ENGINEERING

An Illustrated Weekly Journal

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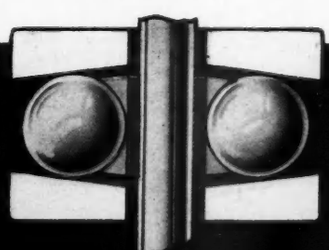

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IT'S NICE TO BE BACK

NEARLY half-way through August it is hard to remain wholly serious. Setting out on holiday involves no complications of mood. The objective is quite clear: to get away from it all. But what of the return a few weeks later?

How absurd is the contrast between the wild people on the beaches at Blackpool and the academic loneliness of the laboratory; between the smooth working of a Swiss hotel and the rather disorganised look of the welding shop; between the nonchalance of the South of France and the forbidding orderliness of the office filing system. Yet, "it's nice to be back." Blackpool was rather nauseating. Switzerland was a little too smooth, and the South of France was really quite ordinary when you got to know it. One is supposed to return from holiday refreshed for another year's work. In practice it is not easy to slip back into the routine. Colleagues make it no easier when they keep asking whether you had a good holiday. It is difficult to concentrate attention when the over-tones of the holiday can still be heard—like the first few days on land after a long sea voyage, when the motion of the ship seems to persist.

The truth is that for the first few days one is a suppressed rebel, like an animal that has had a taste of freedom but has been caught and tricked into the cage again. To suppress this mood of rebellion is, perhaps, to miss a great opportunity. Would it not be better to apply it to a critical examination of the deadly routine? Rather than slip back into the subjective, subconscious mode of action, take up, perhaps, some constructive and imaginative plan that one has been trying to follow up for years. Some day, no doubt, an expert in sociology will produce formidable evidence to show that we are all creatures of circumstance; that though we fondly imagine that we possess unusual drive and originality, 90 per cent. of our thoughts and actions would have been roughly the same for any reasonably intelligent person. But the post-holiday mood might get us out of the rut, if only we let the rebel in us have his chance. He can ask awkward questions, challenge old assumptions. He can see the significance of events and facts which have not been considered relevant before. It requires a certain flair to maintain a constant vigil of all the changing conditions and circumstances which may affect the scope for technical and commercial development, yet it is the ability to do just that which can put one firm or one man far ahead of others within a decade.

Before the first World War, housewives invariably did all their own baking of bread, cakes, etc., since with large families it would have been impossible to buy ready-made food of this kind. But with the increase in the number of childless marriages, and marriages with only one or two children, not only did it become possible for the housewife to afford bought cakes, biscuits and the like, but it was often more economical for her to do so. The figures of biscuit production during the past 40 or 50 years reflect this human change, and those biscuit manufacturers who were the first to recognise the significance to them of changes in the size of families were able to plan for the vastly increased market which they knew was waiting for them.

The practice of engineering inevitably fosters an inclination to plan ahead, but usually only in the restricted sense of planning a specific programme, the need for which has already been established. A more fruitful approach is to question the basic terms of reference. Do buyers of motor-cars, for example, want simply a better car, or do they want a transport-machine-that-gives-them-a-certain-prestige, or an-economical-run-about-that-enables-them-to-have-a-car-for-the-first-time? Even in the case of non-consumer goods, do buyers want a lathe as ordinarily understood, or do they want a machine tool that will produce round-section parts more economically than they have been able to in the past? The answers are not necessarily the same. They will differ in the future to the extent that someone will forget convention, start again from fundamentals and take account of all changes that have any bearing on design, production and marketing. There have been many attempts to explain the differences between the industrial spirit of different countries; between the United States and Europe. It would be foolish to assume that there is a prime cause of these differences, since cause and effect in such matters probably constitute a circle, without an origin. But if there is one difference in outlook which can be recognised, and from which there is something to learn, it is this ability to interpret change, whatever the nature of the change—economic, sociological, political, economic, human, technical, scientific, international, etc.—and to interpret it in relation to the work in hand and the work being planned. Few people in underdeveloped countries have this ability—which is why their countries are underdeveloped. As between fully industrialised countries the differences are probably only marginal, but of course even a marginal difference in the ability to interpret change can, in time, produce a marked difference in prosperity.

Here, within two columns of text, we have forgotten the holiday mood and slipped back into our normal business of being

serious—or almost serious. But the rebel persists. It will be a bad day when he is so completely suppressed that he asks no more questions.

* * *

Plain Words

The Egyptians take an unreasonable pride in the Suez Canal. It is true, as they are fond of pointing out, that Egyptian labourers built it, and that it is in Egyptian territory; but who found the money for wages, and who provided the tremendous drive and skill that were needed for building the canal? Not the Egyptians.

Look at the history of Egypt and it is clear that the people of that country have been lacking in any qualities of initiative, any ability to plan great works of construction, since the days of the pyramids. Forced labour, they are saying to-day, was employed on the Suez Canal. It was employed only for the first five years, under an arrangement concluded by the canal company with the Turkish viceroy in Egypt (with strong disapproval of the system in England); the labourers got better wages and terms of service than they were accustomed to; and when the system was abolished after the death of the viceroy, the speed of construction of the canal was greatly hastened, as modern engineering methods were introduced.

The underdeveloped nations have a long way to go to reach the standard of living that the industrial Western nations have taken a couple of centuries to achieve. The people of Britain, France, the United States, Germany and other countries worked hard for generations. They did not immediately consume all the wealth they created: much of it went into capital equipment. Hence their wealth in the Twentieth Century. They are now able to help countries like Egypt.

British and French pride has been wounded by the seizure of the Suez Canal Company. It is not many years since such an arbitrary move by a minor power would have been countered by immediate military action. The fact that economic and diplomatic moves have been preferred is not a sign of weakness: it shows how anxious the major powers are to avoid war. Nuclear weapons are certainly acting as a deterrent. This profound change in the climate of international affairs is more important than any of the incidents which reveal it—certainly more important than the Suez Canal. But it has presented the smaller states with a freedom to manoeuvre, an opportunity to play off one major power against another, which few of them have the self-discipline to use wisely. Let them remember that they cannot set out on the road to industrialisation without the goodwill of other nations. The Egyptians, especially, should remember that foreign capital and foreign brains built the Suez Canal and much else in Egypt. Seizing the Canal company was a smart move but it will not make them rich. The sooner they acquire a civilised sense of political and industrial planning the better.

CUTTING FUEL COSTS

THE METHODS OF N.I.F.E.S.

Coal production in this country is falling off from year to year and, even though the rate of decrease is small, the position in relation to the demand is becoming progressively serious, as the following production figures in millions of tons show:—

1920	229·5
1930	243·9
1939	231·3
1949	215·1
1955	221·6

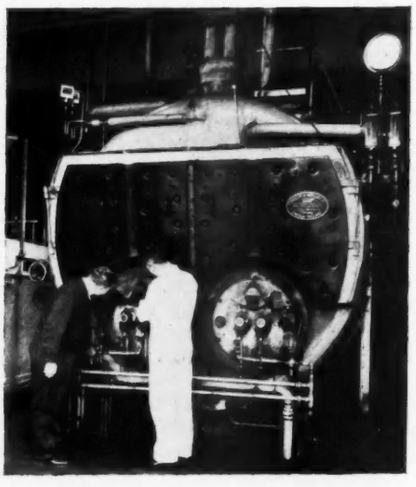
The reasons for this reduction need not be recapitulated, but a widely held belief that the fuel shortage will shortly be offset or entirely overcome by the use of atomic energy has been shaken by the recently published report of the Organisation for European Economic Co-operation, under the Chairmanship of Sir Harold Hartley, the President of the World Power Conference. This report states:

> "Exaggerated statements about nuclear energy have led the public to regard coal as out-of-date and of little concern to them. We must, therefore, draw attention to the adverse effects which this over-optimism over the role of nuclear energy in the future is having on recruitment and scientific development in the coal industry."

After a thorough analysis of the rate of nuclear energy development and the steadily rising demand for energy from industry, the report concludes that nuclear energy is unlikely to provide more than 8 per cent. of the total demand by 1975. This confirms the Government's view that coal will remain the chief source of our energy supplies for many years to come.

At present the gap between home production and demand has to be bridged by importing coal from abroad and last year nearly 12 million tons were required. This cost the country approximately £80 million and further aggravated the already adverse balance of payments. The problem is not one which can be easily or quickly resolved but it is obvious that to make the best and most efficient use of the fuel available is essential.

While interest in this subject is growing, there are still too many managements who, though they are aware that fuel wastage occurs, are not sufficiently interested to probe the cause. The National Industrial Fuel Efficiency Service, more usually known as N.I.F.E.S., hopes to arouse interest and show how other firms have benefited to a considerable extent by looking at their problems in fuel efficiency through the eyes of an engineer who has been trained to do the job.



"On site" instruction of boiler operators is a vital part of N.I.F.E.S. training courses.

ORIGINS AND ORGANISATION

The Service was formed to provide advice and practical help to industry on efficiency and economy in the use of all forms of fuel, heat and power. To this end they were to work in co-operation with other Associations interested in problems connected with fuel usage and they were to give advice to firms and local authorities on smoke abatement. Finally they were to promote the training and employment of fuel technologists, supervisory staff and boiler-house personnel.

Its formation arose from the report of the Pilkington Committee who recommended that industry would be more ready to accept an industrial service than one offered by a Government department. Accordingly the fuel efficiency advisory service administered by the Ministry of Fuel and Power was transferred to N.I.F.E.S. in May, 1954, to be run hence-forward as a non-profit making company under the sole control of its board of directors. The present headquarters of the Service are at 71 Grosvenor-street, London, W.1.

The aim of the Service was to provide, in the early stages, a service comparable with that of the Ministry of Fuel and Power and to gradually expand it at a rate consistent with demand and the supply of suitably qualified staff. N.I.F.E.S. now has area offices in all the important industrial centres in Great Britain and just over a year ago opened an office in Northern Ireland.

Generally speaking the services offered by N.I.F.E.S. fall into four main categories:—

(1) First-Aid Service,
(2) Heat and Power Surveys,
(3) Regular Service Agreements,
and (4) Training and Education.

When the Service is invited to give technical advice a preliminary visit is made, during which there is a visual assessment of the problem and a decision made on the next step. During its first two years, N.I.F.E.S. engineers have made more than 15,000 First-Aid visits, covering some 9,000 firms; this figure represents one in four of all industrial and commercial fuel users in the country.

The First-Aid Service is naturally limited in scope and in many cases a thorough investigation is required before recommendations for improved plant operation can be made. This can best be provided by a Heat and Power Survey, which is the most precise and powerful tool that N.I.F.E.S. can offer to industry. As this service involves a certain amount of planning and preparation and requires considerable experience in operation, it is proposed to describe it in some detail.

HEAT AND POWER SURVEYS

The Heat and Power Survey provides a detailed picture of the use of energy in all its forms. It assesses the efficiency of the whole plant or, if required, of any particular part of it. Results show sources of energy wastage; recommendations are made to reduce this waste and to indicate where and how savings can be effected. Last year the results of over 300 surveys showed that the firms concerned could save on an average 15 per cent. of the fuel they were using and in practically every industry firms were found that were able to reduce fuel consumption by as much as 40 and even 50 per cent.

The surveys are carried out by a team of technicians under the supervision of a qualified engineer. After a preliminary examination and an assessment of the number and types of instruments required, the test team is formed and the necessary equipment is brought to site. The plant is then fully instrumented for the survey.

The obvious place to start is the boiler house, where a complete heat balance is carried out to

calculate the efficiency of the boiler. The method of testing is conventional and measurements of flow, temperatures, pressures, CO_2 and draught are taken in compliance with British Standards requirements, but each case is treated individually in relation to local conditions.

The collected data is then analysed and efficiency figures are calculated. A careful examination is made of the boiler insulation and brickwork surround, the arrangement of the flues and the state of maintenance of the boiler. The results of the heat balance, combined with other observations, are then used to evaluate the operation of the boiler plant and to put forward suggestions for raising the efficiency of the boilers.

It is not only the improvement of performance of the boiler plant which the Heat and Power Survey is intended to achieve. When putting forward recommendations the engineer in charge takes into account the economic aspect and carries out a cost analysis which shows whether it is advisable to make changes in the existing plant or to install new boilers. Statistics produced by the Ministry of Fuel and Power have shown that the average evaporation in steam plants at works using over 2,000 tons of fuel per annum is 6·7 lb. per lb. of fuel, when a figure of 8 lb. of steam per lb. of fuel should be easily attainable if the boiler is run efficiently. This represents some 20 per cent. loss in efficiency.

The same statistical survey states that 49 per cent. of boilers in use are over 30 years old and this is partly the reason for the low efficiency. No industrialist, however, will spend money on new boiler plant unless he is convinced of the economic advantages of the changeover. In this connection N.I.F.E.S. plays an important part because it is the experience of their engineers that by attention to the boiler plant, such as an improvement in firing technique, reduction of air infiltration, effective insulation and covering of feed and storage tanks, recovery of heat from blowdown and the installation of steam jets for cooling fire bars, savings up to 20 per cent. can be achieved.

This represents only part of what can be done to prevent wastage of heat and to utilise the rejected steam from process plant, and these forms of waste may not be obvious without a thorough investigation by trained staff.

LATENT SAVINGS

There are many old and well-established factories which generate their own power but discharge the exhaust steam from their engines and turbines without making use of its heat content. Many industries, in addition to using low-pressure steam for process purposes, require large quantities of hot water. This, in many cases, can be made available by the utilisation of the heat contained in the exhaust from the power-generating plant.

The following table summarises the percentage savings which have been achieved by the implementation of recommendations put forward by N.I.F.E.S. in a number of Heat and Power Surveys of process plant:—

Savings in Process Plant

	Per cent.
Covering of dye-vats	30—53
Effluent recovery from dye-vats	30—40
Insulation of bleaching kiers	Up to 7
Replacement of external heat exchanger by pump circulation round bleaching kiers	Up to 9·5
Mechanical removal of water, hydro-extractors	Up to 12
Air recirculation and humidity control of textile dryers	Up to 35
Vapour recovery from brewing coppers	Up to 48
Condensate recovery and return to hot well	Up to 10
Use of flash steam	Up to 15
Thermostatic control of unit heaters	Up to 16
Effluent recovery from cake washers, rayon industry	Up to 60
Thermostatic control of steam used for direct injection to tanks, vats, etc.	Up to 30
Reduction of steam pressure	Up to 7

The list of items in this table is by no means complete, but it can be considered fairly representative. It emphasises that process plant can be the greatest energy waster and, potentially, the greatest energy saver.

From May, 1954, to March, 1956, N.I.F.E.S. has carried out 822 Heat and Power Surveys covering many industries. The following savings, given by industries, were indicated by the surveys:—

Analysis from Heat and Power Surveys of Fuel Savings in Various Industries

Industry or consumer	Number of reports with complete data	Savings per cent. of consumption
Bricks, etc.	16	17·6
Iron and steel	14	26·9
Textiles	68	17·4
Chemicals	40	12·4
Food and drink	44	14·4
Engineering	26	15·0
Paper and board	19	9·3
Laundries	30	19·2
Leather	16	20·8
Others	57	21·4
Total	330	15·1

The above-mentioned figures refer to 330 works, whose total annual consumption of coal or its equivalent in other fuels is just over 1¼ million tons.

The estimated savings to be obtained by carrying out the recommendations from the surveys are just under 200,000 tons of coal per annum, or 15 per cent. of the total consumption and this represents the minimum figure of possible savings.

As already mentioned, a Heat and Power Survey provides a complete account of the generation and flow of energy, affording a basis for reconsideration of the economics of a plant. The savings listed refer to plants as they stand and only relatively small modifications, involving moderate capital expenditure, were proposed.

Another important point is that any firm contemplating the installation of new plant is well advised to have a survey made before coming to a decision. There have been cases where adjustments and modifications to the existing plant have proved that it is capable of carrying the load without any increased capacity.

To quote two examples where a Heat and Power Survey preceded important managerial decisions:

(1) Surveys of 14 iron and steel plants showed that an average of 27 per cent. of fuel consumption could be saved by the installation of waste-heat boilers. These were subsequently installed and the estimated savings were, in fact, exceeded.

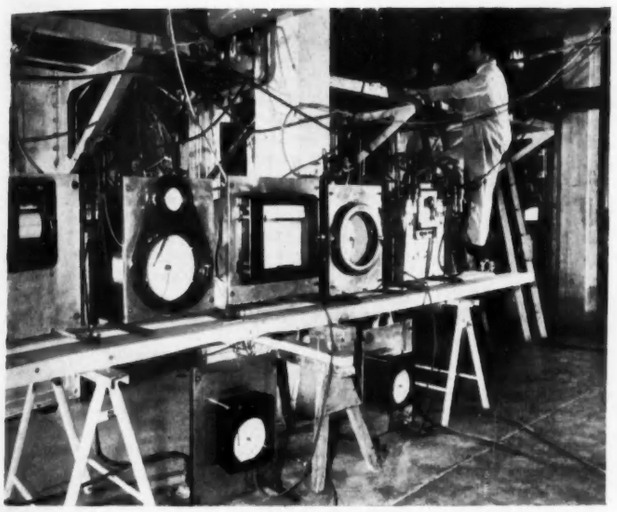
(2) Surveys carried out on the steam raising and power plant of five small gasworks indicated that nearly 10,000 tons of coal or 38 per cent. of the consumption could be saved by modernisation of the plant.

STEAM LINKAGE

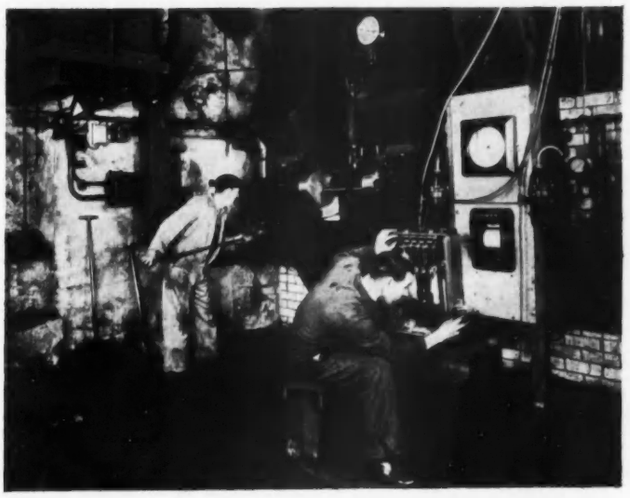
Another interesting possibility for fuel economy is the steam linkage of adjacent plants where one firm is producing steam in excess of its requirements and is prepared to meet the needs, in whole or in part, of the other firm.

Several such schemes have been suggested by N.I.F.E.S., of which two in the London area can be quoted. The first provides steam for the Lechlade Laundry in Kensington from the nearby plant of Davis & Sons (Dyers and Cleaners). The laundry was losing production because of the inability of their old locomotive-type boiler to generate sufficient steam for their requirements. Their neighbours, Davis & Sons, have four Lancashire boilers and were easily able to supply the required steam to the laundry. The result of this arrangement was very satisfactory; the laundry was able not only to increase its production but also to save 250 tons of smokeless fuel a year in exchange for a comparatively small increase in the consumption of low-grade coal by their neighbours.

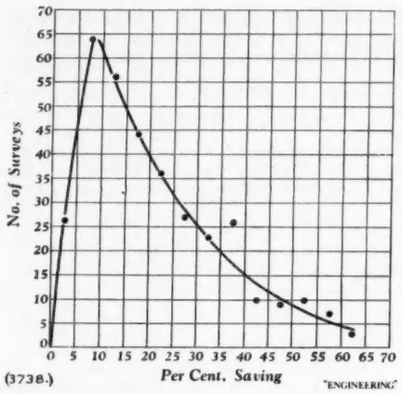
The other scheme, concerning two firms,



Eradicating fuel losses means finding out for certain where the losses occur. An essential preliminary is the installation of appropriate instruments as is being done here at the works of Macleans, Limited, Brentford.



Increasing the efficient use of fuel requires on-site investigation of the normal operating conditions. N.I.F.E.S. is conducting over 50 Heat and Power Surveys in British factories every month and engineers, specially trained for the work, are effecting considerable savings in fuel costs.



Distribution of potential fuel saving among companies surveyed by N.I.F.E.S. Up to 20 per cent. saving usually accrued from changes in the boiler plant; higher savings came from improvements to process plant.

" A " and " B," is now under consideration and will probably be carried out in the near future. Firm " A " burns 21,500 tons of mixed small coal and coke-breeze a year in three water-tube boilers. Firm " B " has three Lancashire boilers burning 2,700 tons of large coal a year. A survey carried out by N.I.F.E.S. has shown that firm " A " is unable to make use of the exhaust steam from their back-pressure plant. It has, therefore, been suggested to them that they can balance their load by supplying low-pressure steam to their neighbours, firm " B." This will result in a saving in fuel consumption and will release the 2,700 tons of large coal at the expense of a small increase in the consumption of low-grade fuel.

SAVINGS TO SMALL COMPANIES

There is also a vast field for general improvement in small power plants and a few further examples of economies achieved as a result of N.I.F.E.S. recommendations are given below.

The brick and tile industry, for example, lends itself particularly to large-scale saving of heat discharged in flue gases. A Heat and Power Survey carried out by N.I.F.E.S. at the tile plant of Henry Hawkins Limited, Cannock, has produced surprisingly satisfactory results. Until last year a large boiler was providing steam for the drying plant. By a rearrangement of ducting and the installation of a filtering system, the gases, after being cleaned, are directed into the tile dryers. The humidity in the dryers is controlled automatically. By elimination of the boiler for raising steam for the dryers, a saving of 1,600 tons of solid fuel a year and the labour of three men has been achieved.

Another example, where fuel consumption has been reduced by 34 per cent., is that of the Scottish firm of carpet manufacturers, Henry Widnell & Stewart Limited. The boiler efficiency of their plant was raised from 67 per cent. to 76 per cent. by attention to the method of firing and draught control. A survey of the process plant resulted in the following changes:—

A non-condensing steam engine driving a hydro-extractor was replaced by an electric motor.

Various items of plant previously supplied with high-pressure steam are now supplied with pass-out steam from the turbine.

As a result of using pass-out steam almost exclusively for process, it has been possible to eliminate a 6 in. high-pressure main.

Return of condensate to the boiler house was increased and the temperature of the feed water is now considerably higher.

A water turbine now provides a proportion of the power requirements and has displaced a non-condensing compound steam engine.

Another interesting case is that described in a Heat and Power Survey report concerning J. W. Leitch and Company, Milnsbridge, Huddersfield. When this works was taken over by new management, Hickson and Welch, Limited, towards the end of 1954, steam was raised in six Lancashire boilers in three separate boiler houses. The management entered into a Regular Service Agreement with N.I.F.E.S. and the most obvious sources of fuel wastage were tackled systematically. First, several steam engines and pumps exhausting to atmosphere were replaced by electrically driven units. Then, following tests in the various boiler houses, it was found possible to run the whole works on two boilers, one boiler house being completely closed. Fuel consumption was thereby reduced from 100 tons a week to 50 to 55 tons a week, despite longer working hours and increased production. Steam-linkage between the remaining boiler houses is under construction and it is expected that a further saving of at least 10 tons a week will be achieved, while maintaining the increased rate of production. In addition to the actual fuel savings, there has been a marked reduction of smoke emission.

DISTRIBUTION OF SAVING

An analysis of results of Heat and Power Surveys for the year May, 1955 to May, 1956, has revealed a very interesting trend. If we group these reports according to the percentage of potential savings in bands of 5 per cent. and plot numbers of reports against percentage saving, a distribution curve is obtained as shown in the accompanying graph. (For instance, the band 15–20 per cent. is plotted at the mean of 17½ per cent., and similarly for other figures.)

Savings of up to 20 per cent. resulted, in the majority of cases, from alterations in boiler plant, whereas higher savings (that is from 20 per cent. upwards) were largely due to improvements in process plant. Although the largest three groups of surveys fall in the first range of savings, the total saved in the second range (process plant) exceeds the total in the first range (boiler plant) by at least 40 per cent.

A similar distribution curve for 1954 to 1955, would show a higher peak in the range of 5 to 20 per cent. due to boiler plant and a lower curve at the higher percentages.

From a preliminary review of results of surveys carried out this year, it can be safely predicted that the trend of increased savings from process plant will be maintained. This can easily be explained. The operation of boiler houses has been improving steadily since the fuel saving and smoke-abatement campaign started. In addition, the various courses for boiler operators, including that sponsored by N.I.F.E.S., have undoubtedly had some effect in the past year. Process plant has not been directly affected by these factors. There has, however, been an indirect improvement because of increased efficiency following better boiler operation.

REGULAR SERVICE AGREEMENTS

A logical step from the Heat and Power Survey was the evolution of the Regular Service Agreement, which has made rapid progress during the past year. It was devised to meet the demand for continued advice which arises once an industrialist appreciates how much fuel can be saved by a high standard of operation and how dependent such savings are on constant attention. A regular visit, monthly or quarterly, by a N.I.F.E.S. engineer gives an outside check on operating standards and, at the same time, provides an opportunity for discussing with a specialist any problem which has emerged. Approximately 340 firms have entered into such Agreements and the service continues to expand.

This type of service is proving particularly attractive to local authorities and other bodies responsible for installations spread over a wide area where N.I.F.E.S. can supply the control which they frequently find a difficult problem.

TRAINING

It has already been mentioned that N.I.F.E.S. sponsor a training scheme for boiler operators. Although courses have been organised at technical colleges throughout the country since 1942, of a total of 80,000 boiler operators only 1,800 had attended courses and sat for the City and Guilds examination up to 1955. The lack of response was caused by many factors, but one of the most important was the reluctance to attend evening classes after a hard day's work. To overcome this difficulty, the N.I.F.E.S. course consists of home study, with " on site " instruction one day every third week under the guidance of a N.I.F.E.S. engineer. The site instruction takes place at the premises of a firm who have agreed to act as " host " to the course and this co-operation has been willingly undertaken by many firms throughout the country. The course is augmented by training films dealing with fuel and combustion.

N.I.F.E.S. is continually expanding to meet the increasing demand for service from industry, and the figure of 12,500 visits to various plants and factories in connection with all services made by N.I.F.E.S. engineers during 1955-56 is a measure of the increasing and deserved popularity of the organisation.

Letters to the Editor

TEACHING THERMODYNAMICS AND THEORY OF MACHINES

SIR, It is usually with the mixed feelings of enjoyment, agreement and irritation that I read the trenchant criticism which so often appears in your reviews of books on thermodynamics and mechanics of machines.

It is undoubtedly true that English text-books have many faults, due perhaps to a very great extent to the fact that they are chiefly designed to cover a particular examination syllabus and not to deal systematically and thoroughly with the pinciples of a subject, and the more frequently this is said as strongly and as aptly as your reviewers do so, the sooner some improvement may be brought about. It is also true, as they say, that American text-books are almost without exception of a much better standard.

These two points are made very clearly by your reviewers, but what is not so clearly nor so fully dealt with—and this is what causes irritation—is what they consider to be the best syllabuses in the subjects and the best approach to teaching them. Even more irritation is caused when, as in the review of Professor Green's book in your issue of July 27, references are given to articles which are not available to the great majority of teachers.

Questions of the content and scope of syllabuses in engineering courses are now of greater interest than usual since technical colleges are preparing schemes for the Dip. Tech. award. This being so, I should like to suggest that your reviewers be asked to follow up their enjoyable iconoclasms by setting out in detail a proposed syllabus for, say, four five-monthly periods in thermodynamics and mechanics of machines, with their treatment of one or two sections which they generally find to be incorrectly or inadequately dealt with in the general run of English text-books.

If this could be done I am sure that their views would be given very serious attention by all teachers of these two subjects, and that they might find a large number of disciples to propagate their gospel.

Your faithfully,
N. GIBSON.

9 Moorville-road,
Salford, 6.
July 30, 1956.

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ATOMIC POWER GROUP

SIR, I was interested to see the reference to my remarks to shareholders at our annual general meeting (your issue of July 27, page 101), but I would like to point out that your reference to the John Thompson Nuclear Energy Company,

Limited, is incorrect. The new company is the A.E.I.-John Thompson Nuclear Energy Company, Limited, of which John Thompson Limited has only a third share; the other two-thirds being owned by the Metropolitan-Vickers Electrical Company, Limited, and the British Thomson-Houston Company, Limited.

Your faithfully,
EDWARD THOMPSON,
Chairman.

John Thompson Limited,
Wolverhampton.
July 31, 1956.

★ ★ ★

ANOTHER NARROW-GAUGE WELSH RAILWAY

SIR, After reading the article on the Festiniog Railway in your issue of June 1, I feel that perhaps your readers would be interested in the Tal-y-llyn Railway which runs from Towyn (Merioneth) to Abergynolwyn. This little railway too has been rescued from complete obliteration, by the efforts of the Tal-y-llyn Railway Preservation Society in which we now have about 1,800 members.

We of the T.R.P.S. claim it to be the oldest surviving steam-hauled passenger carrying narrow-gauge railway in the world which has a continuous record of service. Built in 1865 to a gauge of 2 ft. 3 in. to carry the slate from the quarries of Bryneglwys, in the mountains above the village of Abergynolwyn, it traverses one of the most lovely valleys in Wales. Though it almost fell into disuse after the last war it was rescued by the formation of the society before it actually stopped. It now provides a source of enjoyment to the visitors to Towyn and also to the many members of the society who spend their time and energy working on it on a purely voluntary basis, summer and winter alike, for the love of the job.

Yours faithfully,
C. P. BAINES.

161, Pit-lane,
Widnes.
July 28, 1956.

★ ★ ★

BIG BUSINESS OF MOTOR-CAR REPAIRS

SIR, In your leading article of July 20, "the reduction of employment in the motor industry," was associated with the Government's "extreme measures to reduce the home demand for motor vehicles." Concurrently the daily Press was reporting that the Ministry of Labour had informed redundant motor workers of vacancies in retail distribution and the Post Office. Presumably it would fall to another Department to explain how such labour transfers could benefit the export trade.

A point of importance which seems so far to have escaped official notice is the connection between the output of new cars and the effort required to repair old ones. An inevitable consequence of the curtailment of new car production is the diversion of even more labour to the repair of old cars. Many of these were designed for the speeds and traffic densities of 25 years ago and even if they could now be restored to mint condition they would only continue to obstruct the flow of faster and better-braked trucks and motor coaches.

Since 1945, the work of maintaining obsolete private cars has developed into big business, employing a labour force counted in tens of thousands. Almost every erstwhile one-man filling station has been expanded into a fully equipped engineering workshop. Is there any reasonable justification, political, sociological or economic, for the increasing diversion of labour and equipment from the motor-car factory to the roadside repair shop?

Yours faithfully,
E. H. BATEMAN.

Farnham,
Surrey.
August 3, 1956.

Weekly Survey

Cover Picture: *A ship's propeller, being subjected to torsional and axial forces, must be assembled very carefully on the tail shaft and clamped to prevent any slackening. Accuracy is essential in fitting the propeller boss to a taper on the shaft where it is held by two keys. Axially the propeller is secured by a coned-end octagonal nut screwed on the end of the shaft and locked to the boss by pins which are fastened by locking plates. Finally the octagonal part of the nut is covered by a fairing piece.*

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The Bessemer Centenary

In the coming week falls the centenary of Sir Henry Bessemer's historical disclosure to the British Association, at their meeting in Cheltenham in August, 1856, of his revolutionary process of steelmaking. Referring to it among the "Engineering Centenaries of 1956" in our issue of January 6, we stated that his paper was read on August 13; and thereby let ourselves in for an investigation which was certainly not foreseen when that article was prepared. The assertion was made on the authority of Bessemer himself, for, in his autobiography, published by ENGINEERING in 1905, he described how he was induced by George Rennie to write the paper and recorded that, having done so, he "left London on Tuesday, the 12th August, 1856, for Cheltenham." He went on to tell, with much circumstantial detail, how on the following day he delivered the paper and how, as he was about to leave the meeting, the reporter of *The Times* borrowed the manuscript and promised that "every word of it shall appear in *The Times* to-morrow."

This appeared to us to be conclusive, but it was not conclusive enough for one of our readers. Some time later, we had a letter from Mr. Per Carlberg, a mining engineer of Sandviken, Sweden, enclosing a Photostat copy of the paper as printed in *The Times* of August 14, 1856, and pointing out that it began with the statement that "Mr. H. Bessemer read the following paper at the British Association on Monday last." Now August 14, 1856, was a Thursday, so "Monday last" must have been August 11; yet Bessemer himself had written that he delivered the paper on August 13. "It is, of course, of no real importance if the paper was read a couple of days earlier or later," wrote Mr. Carlberg, "but that day may be taken as the birthday of the modern steel industry and that is, I think, sufficient reason why the date should be stated as correctly as possible." Agreeing entirely with these sentiments, we set out to check the date, but this proved to be by no means easy. The records of the British Association did not give the dates when individual papers were read, so we turned to the files of the *Cheltenham Chronicle*, established in 1809 and published weekly; but while, as happens so often with local newspapers, it dealt at length with the social events, the "elegant cold collations," and the speeches thereat of local notabilities, it did not attempt to report the meetings of the Sections in general. Apart from mentioning (with no date) that a paper "On the manufacture of Iron and Steel without Fuel" was given by "W. Bessamer" (*sic*) the *Chronicle* gave no report of Bessemer's contribution; nor, for that matter, of any other paper in Section G (Engineering). Another local periodical, a small gossip sheet named *The Cheltenham Looker-On*, said of the meeting on August 13 that, "The proceedings of the Sections having been virtually brought to a close yesterday, what was done in them this morning possessed but little interest to the members generally . . ." and indicated clearly that there were no technical sessions on August 13, which was devoted to clearing up the secretarial work of the Sections.

Finally, an appeal was made to the Cheltenham Librarian, Mr. H. G. Fletcher, F.L.A., whose public library and museum contains an extensive collection of old Cheltenham newspapers. At last, firm ground was reached. "With reference to your inquiry," he replied, "I have to inform you that the *Cheltenham Journal* for the 16th August, 1856, states that this paper was read on Monday, 11th August." So Bessemer's memory (or, possibly, his diary) must have been at fault, after all. It should be borne in mind that, when preparing his reminiscences, he was writing 40 years after this particular event; but it must be admitted, also, that Clio, the Muse of History, has a worthy disciple in Mr. Carlberg of Sandviken.

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More Data for Crystal Gazers

The Chancellor of the Exchequer announced in the House of Commons last week that the Government were putting in hand immediately a programme to gain further statistical information about industry. The object of the scheme is to provide the Government with new data on the probable trend of economic events.

The list of information to be obtained is somewhat daunting. Certain important industries, not already giving the information, are to be asked for monthly figures about production and orders. A compulsory annual sample inquiry is to be made into fixed investment and stocks in the distributive trades. The distributive and service trades are also to be invited on a voluntary basis to give similar information quarterly. The building and civil engineering industries are being approached by the Ministry of Works to see if they can give analysed information on new contracts. A sample of companies is to be invited to give quarterly estimates of profits in confidence to the Inland Revenue. Only summaries of these profit figures will be available even to other Government departments. Certain other statistical changes are proposed, including sample inquiries on household income and expenditure.

Mr. Macmillan has said that certain non-essential statistical returns will be scrapped but it will be surprising if there is not on balance an increase of work placed on those companies who take part in these new statistical investigations. It is to be hoped that the cutting down of form filling in some directions works out to the benefit of those companies which are to be asked to take on the new work. It would be very easy for some companies to lose forms while quite a different group of companies gained the new ones. In principle, there is much to be said for the Government improving the means of assessing future trends. Far too much statistical effort in the past has gone into writing recent history. It is certainly time that such confidence as has been engendered in statistics dealing with industry should be capitalised to obtain figures which will help the Government to foresee the trend of profits, investment and employment. In practice, the forms should be kept to the minimum and should be clear and simple in their questions. If this is not done, more exasperation than co-operation will be forthcoming.

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Locomotive Manufacturers Go Ahead

A useful and important future lies before the Locomotive and Allied Manufacturers' Association of Great Britain in discharging its wide functions of fostering the welfare of the locomotive and cognate industries in this country. The Association, which was set up in January last, deals with both steam and Diesel motive power, and has replaced the now-dissolved Locomotive Manufacturers' Association. A recent step in the development of L.A.M.A., resulting from the growth of the Association's activities and the consequent additional demands upon the time and energies of its officials, is the creation of the post of chairman.

The President for the ensuing year is to be Mr. Harold Wilmot, C.B.E., who, as chairman and managing director of Beyer, Peacock and Company, Limited, has played a significant

part in the progress of the locomotive industry' and who is keenly interested in the development of the locomotive export trade. Among his many services to the industry may be mentioned his work as President of the old Locomotive Manufacturers' Association during the difficult post-war years from 1947 to 1950. For the newly-established position of chairman, the Association has selected Mr. C. C. H. Wade, manager for traction sales and contracts to the English Electric Company, Limited. To this appointment Mr. Wade brings experience gained during more than 30 years of service to electrical engineering, all of which have been spent with English Electric, whom he joined as a student apprentice in 1922.

The headquarters of L.A.M.A. are at present at 82 Victoria-street, London, S.W.1, but will be transferred to a fine new building, Locomotive House, Buckingham-gate, London, S.W.1, at the end of next month.

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Amusement for the Traveller

At Graz, in Austria, the railway station has been equipped with a reading and play room for schoolchildren, so that they can pass their time agreeably while waiting for trains. They may also bring their lunch, use an electric oven for warming food and a sink with hot water for washing-up. The room is open from 7 a.m. to 8 p.m. and is stocked with educational and adventure books, magazines and various table games.

The Netherlands Railways were the first to try out this amenity. The Austrian Railways took it up, first at Innsbruck and then at Graz. It is by innovations of this kind that railways throughout the world might succeed in banishing passengers' usual attitude to stations—that they are gloomy places where one invariably just misses a connection. But would it not be better to provide some special facility for adult passengers ?

After all, most schoolchildren—the boys anyway—already find sufficient attraction in locomotives. The playroom will be useful in drawing them away from the ends of platforms, where they can be a nuisance to the operating staff, but the hardened traveller will still wish he were in a car or an aeroplane. Perhaps the neatest solution would be to provide a room with a model railway. It would certainly appeal to the fathers, and when the boys become fathers themselves they will be able to take their sons and show them what splendid machines locomotives used to be.

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Pye's Progress

The successful results of Pye Limited, in their financial year ended March 31, is a good example of how a company making primarily durable consumer goods can benefit from diversification into industrial markets. The company have recorded a moderate increase in profits, which suggests that either the credit squeeze did not become effective in reducing home sales of radio and television sets until after the first quarter of this year (it began in September, 1955), or that Pye's expansion in industrial fields has already begun to pay dividends.

Both have doubtless contributed: hire-purchase restrictions rather than credit squeeze have reduced domestic sales, but "reduction" was not absolute—only a reduction in a very steep rate of increasing demand. Production of radio and television receivers began to fall back in December, from a peak monthly output in September to November, 1955 (370,000 units) and fell fairly heavily during the first four months of this year, when it averaged less than 260,000 units, a fall of nearly 30 per cent. The development of export markets—probably at a greater rate than any other manufacturer in the industry—was a major factor in enabling the company to offset the decline in home sales of radio and television. Another was the introduction of new products, such as transistor portable and car radios, and the launching of new models of television receivers. There has been much energy and a great deal of foresight in the sales promotion of the company's consumer products. At the same time Pye have developed new uses for television and radio. No company has played a bigger part in the establishment in this country of a market for industrial television. Closed-circuit chains are now selling in increasing numbers as industrial equipment to enable close observation of processes from a central control point. Sales in other fields, such as underwater television, teaching, advertising displays, are also on the increase. The growth in the use of television for industrial, scientific and commercial purposes was described in an article in the July 27 issue of ENGINEERING.

Pye's dependence on the domestic market remains, but their attempts over the past few years to lessen this dependence by diversifying and by vigorous sales promotion overseas have contributed in no small measure to their present relative strength in their industry.

Donald Campbell—holder of the world water speed record.

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Campbell's New Attempt

The work of modifying Donald Campbell's "Bluebird," in preparation for the new record attempt in September, was started five months ago in the workshops which adjoin Campbell's lovely old house in Surrey. There is nothing very elaborate, from the engineering point of view, about the shop in which Bluebird is supported on trestles while Leo Villa and his assistants work on the hull, nor is the nearby workshop at all lavish in its equipment, but there, in a remote farm-like setting, Campbell's team have been working long hours in order to get the boat ready for exhibition at London's Festival Gardens in Battersea Park, where it will be shown until August 29.

The modifications have been mainly to the hull, particularly the cockpit and canopy arrangements, the air intake to the jet engine and the form of the ballast tanks. The Mobil Oil colour film of the record-breaking runs at Lake Mead last November is also being shown, along with Bluebird, at the Festival Gardens. One can see from this film how critical is the risk, when travelling at over 200 m.p.h. on water, of the boat getting into porpoising trouble or striking a series of waves which might cause resonant pitching. At this speed only about 18 sq. in. of the boat are in the water. Campbell will probably use a parachute drogue when he goes to Lake Coniston in September, since by this means the deceleration time at the end of a record attempt is reduced and the drogue can also, if necessary, be used to retard the boat quickly if it should strike an uncomfortable stretch of water.

Earlier in the year Campbell had intended to return to the United States this autumn, so that he could try and beat his own record of 216·2 m.p.h. Unfortunately, during the past few months there has been a long drought at Eagle Mountain Lake in Texas, which has had the effect of reducing the available stretch of water. Loch Ness, in Scotland, has the length required for a record attempt, but it is so seldom smooth enough throughout that Campbell has decided on Lake Coniston in Lancashire. Even Lake Mead, in the United States, gave Campbell very little margin for accelerating and decelerating.

The jet engine, a Metropolitan-Vickers "Beryl," with a thrust of 4,000 lb., is of the same type as the one used previously. When Campbell arrives at Coniston on September 10, and attempts to beat his own record about ten days later, he will, with luck, make it more difficult for the new American jet-propelled boat, which is expected to make an attempt later this year, to wrest the record from him. When he established the present record, Britain became, for the fourth time, the only country ever to hold the triple crown for the three speed records —land, water and air—at the same time. Campbell and his team do a great job. Praise, also, to the industrial firms who back him with money and assistance.

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Edgar Allen & Co. Ltd.

The effect of rising costs in the engineering industry, particularly in the case of companies which sell an important part of their output at controlled prices or are attempting to avoid raising prices, is brought out in the accounts of Edgar Allen and Company, Limited, for the year ended March 31, 1956. The chairman, Mr. W. H. Higginbotham, F.S.A.A., F.S.S., points out that after a period of ten years in which a substantial improvement in the company's financial position took place the sequence has now been broken. Although total turnover of the parent company and its seven subsidiaries was slightly higher than in the previous year, trading profit fell from £837,401 in 1954-55 to £703,596 in 1955-56, and the net disposable balance from £335,503 to £159,937.

The parent company's products cover a wide range including special steel, magnets, tools, etc., which are estimated to have accounted for 40·4 per cent. of total sales in 1955-56, steel castings 30·2 per cent. and engineering and track-work 29·4 per cent., of which cement-making machinery, crushing and grinding machinery and rotary dryers account for a high proportion. In 1955-56 the tools and magnet sections showed increased turnover and profit; steels, despite considerably increased turnover, showed a substantial reduction in profit; while the engineering section, due partly to a break in continuity of contracts, showed a considerable increase in overall costs and reduction in profit. This section began work during the year on a contract valued at £750,000 for a cement-making plant in Iran.

Among the principal cost increases during the year, the most important was a 20 per cent. increase in the cost of alloys (particularly nickel alloys) of which the total consumption is equivalent to about 10 per cent. of turnover. Coal and coke increased in cost by 11 to 13 per cent., labour costs by 6 per cent. and consumable process materials such as sand, grinding wheels and oxygen by 5 per cent.

The company reports, however, that even excluding the cement plant contract mentioned above, orders in hand both in volume and value were considerably greater at March 31, 1956, than at the corresponding date in 1955, and that as a result (unless any serious increase in wages should occur) trading results for 1956-57 should be substantially better than those for 1955-56. This is not a matter of interest solely to the shareholders since the maintenance of the company's extensive research programmes and

modernisation of plant, without which the company cannot maintain its competitive position in export markets, is dependent on an adequate margin of profit.

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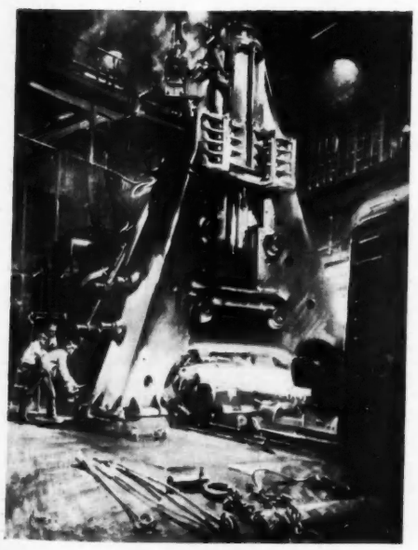
Production at Midsummer

According to provisional estimates by the Central Statistical Office, the index of industrial production was between 139 and 140 for June, 1956 (the base year, 100, being 1948). If this figure is confirmed it will be the best performance since March and about equal to that for May, 1955. Comparisons with June, 1955, would be naturally favourable to June this year owing to the dock and rail strikes last year.

It is not likely that the provisional estimate for June will be seriously altered when final figures are available, though to judge from recent experience the revision may put the index nearer 139 than 140. The June estimate, however, may not be a reliable guide as to what is likely to be occurring in the third quarter of this year. In July the strike of steel maintenance workers will have affected output, and the continuing troubles in the motor-car industry may yet offset the improved car production performance in June. By and large, industrial production is gradually losing its rate of increase—a state of affairs to be expected as one group of engineering activities contracts while another expands.

What is the outlook for the autumn? There is every indication that a wide range of engineering activities will maintain their prosperity and they may even benefit from the price stabilisation scheme. On the other hand, the outlook for the motor-car industry remains confused and there are the first signs of a prospective decrease in industrial building activity. Up to the end of June, the total area of new buildings notified as having been started in the first three months of the year was 13·2 million sq. ft., compared with 12·2 million sq. ft. in the fourth quarter of 1955, but with higher figures in the second and third quarters of last year. The estimate of 13·2 million sq. ft. is likely to be revised upward in the next few weeks, which will show " factory starts " at a significantly higher level than in the closing months of 1955 though below the high level of the earlier part of last year. In contrast, however, the amount of building approved in the second quarter of 1956 has dropped to 14·4 million sq. ft., compared with 21·7 million sq. ft. in the first quarter of this year. It is thus apparent that there is a very big volume of building activity to be worked off in 1956 which is likely to be followed by a notable reduction in activity in the spring of 1957. If they are correct who say that much of the inflationary pressure has been stimulated of late by the high volume of building activity, the Ides of March 1957, may have particular significance.



Forging hammer at International Nickel Company's works, West Virginia. Painting by Terence Cuneo. (See " In the Picture.")

★ ★ ★

Settling Redundant Workers in France

Typical of the backward pockets of the French steel industry up to a few years ago, when the Common Market for steel was opened, was the Saint Etienne area in Central France, where within a 10 mile radius four plants produced between them some 200,000 tons a year. To meet competition the four plants were merged as the Compagnie des Ateliers et Forges de la Loire, and a large number of workers declared redundant. As this was a direct consequence of the opening of the Common Market, help could be sought under the terms of the Treaty. The French Government and the High Authority put up jointly the sum of £300,000 for financial aid to the displaced workers.

This money was spent in three ways: the basic wages of those laid off; the cost of training those who would have to go to other jobs within the industry; and the cost of moving workers who had to go to other plants, to whom a settling-in allowance was paid. No one was moved farther than 17 miles. This scheme has worked smoothly because it has been carried out gradually and, in fact, will not be completed until 1958. The present boom in steel has meant that even the most backward plants could sell all the steel they could produce while reorganisation was going on. The fact that there were to be no mass sackings meant that the trade unions encouraged their members to co-operate with managers in the scheme, although the Saint Etienne area has a tradition of bad labour relations.

The complaints made by the workers are interesting. They say that they have little knowledge of what is going on except in their own plant. The fact that it is the employers who control the spending of the £300,000 grant is criticised. Once the scheme was agreed, both the French Government and the High Authority faded into the background and, the complaint is, became absorbed in book-keeping. Other complaints concern the scale on which basic wages are calculated. The biggest objection to the scheme is that thousands of workers are outside it, the High Authority being concerned only with steelmakers. For these other men there is only the state unemployment benefit—about one-third normal wages. But in spite of the complaints there is general agreement that what has happened is a big improvement on previous practices.

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Volkswagen—The Managerial Paradise

The Volkswagen company was set up by Hitler before the war at Wolfsburg on a site chosen because it was at the exact geographical centre of the Reich. The car itself was designed by Ferdinant Porsche to sell at 1,000 marks (£85 pre-war), to be within reach of the average German worker. The so-called " Volkswagen savers " had subscribed 5 million marks at the rate of five marks a week by the outbreak of war. Only 210 cars were built, however, before the plant turned over to military production. After the war the British Military Government picked Dr. Heinz Nordhoff to be general manager and get the plant working again. Nordhoff had formerly been head of the Opel (General Motors) lorry works at Brandenburg, now in the Eastern zone. Since then Volkswagen has never looked back. In 1955, output was 330,000 cars representing over 40 per cent. of German production.

The remarkable thing about Volkswagen is that it is a company without an owner. The German Finance Minister acts as a trustee for either the Federal Government or the province of Lower Saxony. Which is the legal owner has not been decided, and although court proceedings have been started there seems to be no great desire to arrive at a decision. In the meantime the Volkswagen is maufactured by severely standardised methods to a practically unchanging design. It sells at a wide profit margin which in the five years from 1950 to 1954 brought in nearly 15 million D.M. The company has no ordinary capital to service, but in each of the five years a dividend of 4 per cent. was declared which was paid out as an output bonus to the workers. A large sum was also set aside to meet the claim of the " Volkswagen savers " for 200,000 cars should the courts decide in their favour. After setting aside the dividend, some 7,755,241 D.M. remained to be ploughed into the company.

Under German company law, Volkswagen has a supervisory board (Aufsichtsrat) of 15 members, of whom five represent the employees, and a managing board (Vorstand) of two—Dr. Nordhoff and his deputy. Wages are higher and hours shorter than in any other plant. Small wonder that Volkswagen has been called a managerial paradise.

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In the Picture

It is in the public's own interests to know what industry is like from the inside, and how better can an impression be conveyed than by the work of a talented and perceptive artist let loose on an industry's premises? Mr. Terence Cuneo has served both public and Mond Nickel well in a collection of paintings commissioned by the company and recently exhibited in London. He has caught the sense of sweat, shouted commands, and the spine-shaking thud of hammer blows in his picture of a forging shop, and, in another, the scorching glare of billets as they pass through a rolling mill. Pickling vats, extrusion presses, Bessemer converters, laboratories and the men who run them are all depicted with a familiarity that would seem to come from long acquaintance (though perhaps a man who had worked with metal for many years would have been less impressed by the reds and yellows of furnace flames and white-hot steels, and attended rather to the subtler hues of his workplace).

Equally impressive is a new film " Mining for Nickel," made for the International Nickel Company of Canada, Limited, which will shortly be available for loan in the United Kingdom. In this case, the publicity man's public service has been in terms of instruction, for there could be few better introductions to the technical problems of large-scale mining than this excellent colour film. Using animated diagrams and working models to explain engineering methods, the film succeeds also in entertaining, being particularly spectacular in underground and open-pit sequences and in one shot where half a million tons of ore are blasted simultaneously.

The film opens with a brief account of the first discovery of the vast nickel copper sulphide deposits in the Sudbury district of Ontario in 1856, and continues with a detailed description of modern exploration methods and the mining techniques used to-day, when the production of nickel ore from the company's mines has grown to nearly 15 million tons a year, with underground workings totalling some 400 miles. Shaft sinking and drifting operations were filmed at the Levack mine; square-set, blast-hole and open-pit operations at the Frood-Stobie mine; shrinkage and cut and fill at Garson mine; and caving at Creighton mine.

The film lasts for 45 minutes and, like Mr. Cuneo's paintings, helps to portray an industry. To act as impressario in presenting industry to the public is the task of the publicity man, and we should be grateful to him for putting us in the picture.

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Trade Unions in Western Germany

One of the most important factors in bringing about the post-war recovery of Germany has been the restrained behaviour of the trade unions.

Free trade unions were abolished by the Nazis, and from 1933 to 1948 there was no collective bargaining in Germany. The present system started virtually from scratch in 1946 with a new union set-up. Its founder was the veteran labour leader Hans Bockler, first chairman of the German Trade Union Federation (D.G.B.). The original plan was to have a single union with sub-divisions for the various industries. This idea was dropped in favour of twelve, and later sixteen, unions on the basis of industrial unionism. Industrial unionism has the big advantage of eliminating demarcation problems. Everyone who gets his living in an engineering works belongs to the Metalworkers Union whether he uses a screwdriver, a broom or a whitewash brush.

Another fundamental difference between German and British trade union practice is that the unions try to gain their industrial aims by legislation rather than negotiation. This is particularly so in the movement for a share in the management of German industry which is called *Mitbestimmung* or co-determination. Under German company law each joint stock company has a supervisory board (*Aufsichtsrat*) and a board of management (*Vorstand*). The Law of Co-determination of 1951 provides that in the coal and steel industry five of the eleven members of the supervisory board and one member of the board of management shall be nominated by workers. This system is still in its early days, but there is widespread demand for it to be applied to all industries, particularly the inclusion of Labour Directors on the boards of management.

The broad objectives of the D.G.B. are: an expansive wages policy; the introduction of the 40 hour week without loss of pay; full employment; improvement of the social services; and maintenance and extension of co-determination. The question of nationalisation is not of importance in the German unions. Much more emphasis is laid on the workers sharing in the control rather than the ownership of industry. The idea behind the expansive wages policy is that labour should have an increased share of what is produced. It is pointed out that increases in productivity have been well over twice as great as wage increases since 1951. The 40 hour week is still a long way off, as the average week for men is 49·2 hours and women 41·1 hours.

Union membership is low by British standards and there is no movement for a closed shop. Two big white-collar unions, the Salaried Employees Union (DAC) and the Civil Service Federation (DBB), and the Union of Police Officials (GdP) are outside the Federation. The German unions are not affiliated to any political party and none of the unions are organised on a denominational basis. The Communists have not been allowed to gain control of the works councils or to win key positions in the union hierarchy. Bitter experience of close contact with a Communist regime in the Eastern Zone has been a most effective form of anti-Communist propaganda.

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Oxygen for the Steelmaker

Last week a button was pressed in London and the first British tonnage oxygen plant—situated at Margam in South Wales—came into operation. At the same time viewers in London saw the drive to the compressors start to rotate, and afterwards were taken on a visual tour of the new plant—made possible by use of a closed-circuit television link.

Because of the weather, the proxy visit was a success, and viewers learnt that the British Oxygen Company's tonnage plant at Margam could produce 100 tons of high-purity oxygen a day; this would be piped directly to the Abbey Works of the Steel Company of Wales. There it would be delivered to open-hearth furnaces by means of water-cooled guns inserted through the furnace roofs, and would assist in removing carbon and other impurities from the metal. An oxygen gun projecting into a furnace can be seen in an illustration on this page. Injection through the roof avoided interference with the charging bogies, and water cooling gave the gun a longer life—up to 80 heats—than was possible with an ordinary lance. It was estimated that the use of tonnage oxygen in this way would effect an increase in steel production of some 10 per cent., though by use of flame enrichment and other techniques the increase might be as much as 20 per cent. or more. But in that case problems concerning the refractory lining of the furnaces might arise. The term, tonnage oxygen, it was explained, merely indicated the scale of production; but making it in such large quantities and piping it directly to the steelworks made possible its distillation from liquid air by the Rescol (regenerator single column) process at low cost.

Oxygen injected into an open-hearth furnace by a probe inserted through the roof. With the construction of the new tonnage oxygen plant at Margam, oxygen can be delivered to the steelworks in large quantities continuously by pipeline. (See " Oxygen for the Steelmaker.")

Mr. J. S. Hutchison, chairman of the British Oxygen Company, Limited, speaking in London on this occasion, said that another plant, this time of 200 tons a day capacity, was to be built at Margam, while Scunthorpe and Middlesbrough were each to have 200 ton plants, and Consett, Co. Durham, and Ebbw Vale were to have plants of 100 tons capacity. These would come into operation one after another between the present and 1958. The Shell company required two plants of 150 and 250 tons a day output, while another plant, of 300 tons a day, was also being constructed for a purpose other than steelmaking. For the steel industry alone, he said, his company was building tonnage oxygen plant with a capacity exceeding 350,000 tons a year.

★ ★ ★

New Viscounts and Britannias

The last week in July brought news of the first flights of two important British airliners—the Viscount 802 and the Britannia 301.

The Viscount 802, now undergoing test flights, is expected to be delivered to British European Airways in about two months time for proving flights. It is the first of 24 of the type which are expected to add to the prestige that British European Airways—now Europe's largest operator—have built up during their first ten years of existence. The Viscount 802 has been developed by Vickers-Armstrongs Limited, Weybridge, from the Viscount 700 series to the special requirements of British European Airways, in close collaboration with B.E.A.'s project and development branch, and the resulting aircraft, intended for short-medium ranges, is a most versatile and attractive machine from the operator's viewpoint.

The Viscount 802 has a longer fuselage than the earlier aircraft, giving a capacity for up to 70 passengers in the high-density version. Normally it will be arranged to carry 53 first-class passengers or 58 tourist passengers. The cabin floor has been strengthened so that a mixed passenger-freight load can be carried in the cabin, and a large rectangular freight entrance door, 5 ft. by 4 ft. is provided forward. Passenger entry doors, normal and emergency, are provided at the rear on both sides of the aircraft. There is in addition a large freight hold under the floor.

The Britannia 301, prototype of the 300 series, which has recently flown for the first time, is fitted with more powerful engines than the 100 series version now undergoing proving trials with B.O.A.C.—four Proteus 755 propeller-turbines each developing 4,120 equivalent h.p.—and has a higher cruising speed of about 390 m.p.h. The fuselage, too, is longer, and will accommodate over 100 passengers. B.O.A.C. expect to take delivery of the first of this type early next year. They have on order two Britannia 302 aircraft, five 305's—basically 302 aircraft with strengthened wings to take extra fuel tanks—and 11 series 310 Britannias, the long-range version which will be capable of regular non-stop trans-atlantic operation. Like the Viscount 802, the cabin of the Britannia is designed with movable bulkheads and adjustable seat rails for a rapid change-round of cabin layout to suit the requirements of the operator.

★ ★ ★

I.C.I. Peg Prices

The announcement by the board of Imperial Chemical Industries Limited that the prices of most of the company's products would not be increased during the next eleven months is tangible proof that the Government's price stability campaign is making good progress. The statement issued after last week's meeting between members of the Government and representatives of industry suggested that much more progress had in fact been made than had been expected by even the keenest protagonist of the campaign. Should any support be forthcoming from the Trade Unions—at present there are few signs of this—inflation may well be held in check despite prevailing shortages.

The I.C.I. statement is cautious. The board's decision is subject to the proviso that " no unexpected or exceptional factors intervene, and provided the company does not incur any major increase in the cost of freight or fuel before that date (June 30, 1957)." A number of products are excluded, particularly those involving non-ferrous metals, which " depend markedly on imported raw materials which fluctuate widely in price." The Suez Canal crisis showed how quickly and unexpectedly this can happen, by sending non-ferrous metal prices sharply upwards. Yet the Government take the view that external factors over which industry has no control are insufficient to wreck price stability, and they are probably right. The threat comes from the relentless upward pressure of wages, and this in turn from " over-full " employment. Industry, and members of the Government, make no secret of their desire to see a little more redundancy around. For different reasons, the Labour Party and a good many trade union leaders may not be averse to this happening. The sluggishness of their followers has given them cause for concern, especially over the response to the B.M.C. strike call.

The Government will now try to repeat with the unions the success they have had with industry. They will not lack supporters among the more thoughtful leaders. But, as is the case with the employers, support in general terms from representatives falls short of what is needed: thousands of large firms have yet to follow the example of I.C.I. How much greater the effect had the company's statement been made not by the board but jointly by management and employees ? In this, as in many other matters of common concern to both sides of industry, local action at company level—when the identity of interests is clearest—is an ideal worth striving for.

BOX BEAMS UNDER CONSTRAINT*

STRESSES DUE TO SHEAR LAG AND TORSION

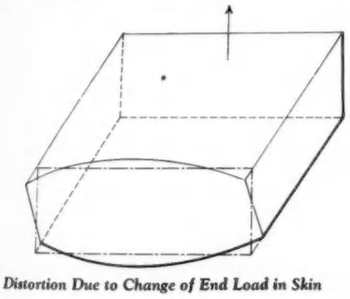
By D. Howe,† D.C.AE., A.F.R.AE.S., and K. H. Griffin,† B.SC., A.F.R.AE.S.

The use of box beams with thin walls in structural design gives rise to a range of special problems in strength analysis. The Britannia Tubular Bridge and, more particularly, aircraft wings, are examples of such beams, of approximately rectangular cross-section. Provided certain conditions are fulfilled, the use of the Batho-Bredt torsion and conventional bending theories give a reasonable prediction of stress. Perhaps the most important such condition is that the section under consideration is removed from the effects of supports and applied loads. If this is not so, a modification to the elementary stress distribution occurs, an important instance of which is at the root of a built-in cantilever. This modification is known as a constraint effect. The paper reviews methods which have been used to consider these constraint effects, and further solutions based largely on Castigliano's Principle of Minimum Strain Energy are suggested. Particular emphasis is placed on the case of a swept aircraft wing, the effect upon the stress distribution of concentrated end-load carrying members, and the rate of die away of the constraint from the fixation being investigated. Constraint effects are shown to be of importance in aircraft wing structures, particularly in the swept case. The effect of concentrated booms in reducing constraint effects is demonstrated. In certain instances, comparison is made with experimental results. Good agreement is obtained.

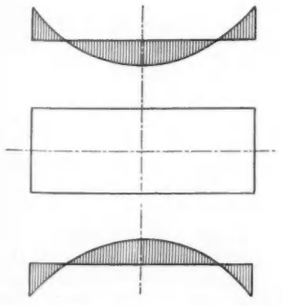
Box beams find a wide application in engineering. In normal civil-engineering applications they are relatively deep compared with their width, while in aircraft-wing structures the depth is relatively small and the box is required to carry high torsion loads in addition to the bending.

* Paper read before Section G of the British Association at Bristol on Tuesday, September 6, 1955.

† Lecturers in the Department of Aircraft Design, College of Aeronautics, Cranfield.



Distortion Due to Change of End Load in Skin



Direct Stress Distribution Required to Constrain Distortion

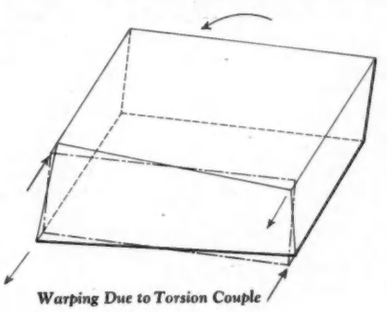
(3198.A.) "ENGINEERING"

Fig. 1 Stresses due to shear-lag constraint.

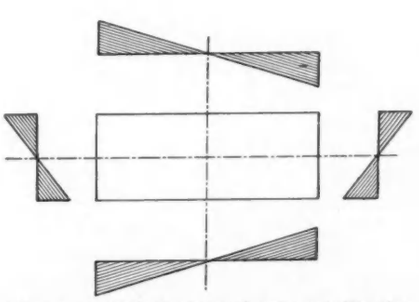
As a result of this the approach to the design of a box beam as used in aircraft wings is somewhat different from that more commonly used.

The load-carrying function of an aircraft wing has developed with aircraft design. In the earliest wing structures the bending load was taken by one or more spanwise beams or spars, usually of I or channel section. The wing section was completed by a number of chordwise members, or ribs, used to transmit air load to the spars, and a fabric covering. As aircraft progressed it became necessary to provide a more substantial torsion-carrying member, and coupled with the need to save as much weight as possible, the skin between the two spars became metal and was designed to carry shear loads, thus completing the torsion box. Later this skin was made to carry part of the bending load by stiffening it, although substantial booms located at the spars were retained. The most recent development is to carry all the bending in the skin, using the spars to carry shear loads only. In the case of some very thin wings, the skin stiffeners are joined top and bottom to form a multi-cell box, but the scope of the present paper is limited to single-cell beams.

The strength of these box beams has been estimated using the conventional bending and Batho-Bredt torsion theories, and these give adequate results at points removed from discontinuities. Departures from the elementary stress distributions do occur, however, particularly at the root of a built-in cantilever, a condition often approached in a wing. Since one of the most important assumptions of the above theories is that the cross-section of the beam is free to warp, it is clear that at a section where this warping is constrained such departures may occur. Constraint against free warping occurs where beams are built into a more or less rigid structure, or at points of concentrated loading, where the displacements due to elementary theory are incompatible on either side of the point of load application. An example of the latter case is given by Parkes.[22] It is clear



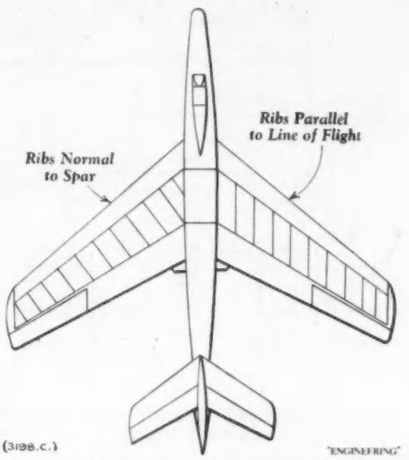
Warping Due to Torsion Couple



Direct Stress Distribution Required to Constrain Warping

(3198.B.) "ENGINEERING"

Fig. 2 Stresses due to torsion constraint.



(3198.C.) "ENGINEERING"

Fig. 3 Alternative rib configurations; rib direction is significant to the constraint at the wing root.

that, since the elementary stress distributions are statically correct, the constraint stresses which modify them are statically zero, and thus by St. Venant's principle, die away relatively rapidly from the constrained section.

Shear Lag and Torsion Constraint.—In an unswept box beam both bending and torsion loads induce cross-sectional warping when constraints are absent. The type of distortion in the case of bending due to tip shear is shown in Fig. 1. Since the web distortions are in the same sense and are sensibly linear, they can be accommodated by a rigid-body rotation. The top skin, however, requires tension in the centre and compression at the edges to eliminate the warping. It is clear then that the constraint stresses in the box will be almost entirely confined to the skins, and are approximately parabolic.

The explanation of the name "shear lag" is that the function of the shears in the skins is to build up the skin end-loads from the web shears. At, or near, a constrained section the skin shears are reduced almost to zero and the shear "lags behind" in its function. Thus the bending stresses in the centre of the skins are reduced, while those near the webs are increased above their "beam-theory values." While shear lag is largely a skin phenomenon, torsion constraint stresses occur in both skins and webs. If the skin and web thicknesses are proportional to their widths, then simple theory gives no warping, and thus there can be no constraint stresses. When the cross-sectional proportions vary from these, warping of the nature shown in Fig. 2 occurs and direct stresses of a similar pattern are required to eliminate it. The spanwise variation of these direct stresses involves shear stresses which considerably modify the elementary distributions. If the root fixation is not normal to the span, as in a swept wing, the problem is more complex and it is not possible to separate these two effects.

PROBLEM OF THE UNSWEPT STRUCTURE

It is in order at this point to make a brief review of the methods with which the unswept constraint problem has been tackled.

Torsion Constraint.—One of the earliest papers on torsion constraint was that by Reissner[3] in 1926. He considered a uniform doubly symmetric rectangular box in which the cross-section was maintained by closely spaced rigid ribs. Equal and opposite direct loads were carried by concentrated booms and the skins and webs carried only shear stress. A displacement, or fundamental, type of solution was used to estimate the constraint effects.

Ebner[4] and Williams[5, 6] extended this approach to give more exact solutions, including the effect of taper. Ebner allowed for discrete flexible ribs. Cox[6] also has investigated taper and flexible ribs, together with the effect of cut-outs

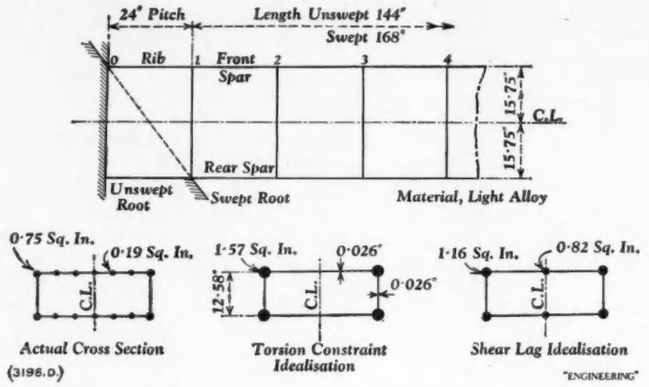


Fig. 4 Unswept and " normal " rib swept boxes, structural details.

in the walls of the box. Kuhn[10] and Fine[11] contributed work on more general cross-section shapes.

Shear Lag.—The problem of shear lag was investigated by Schnadel in 1928. An idealisation of the structure into a number of concentrated end load carrying members, with shear carrying skins between was made. Williams and Fine[9] and Hemp[12] examined the shear-lag effect by expressing the stresses as a Fourier series along the box length. Closely spaced rigid ribs were assumed.

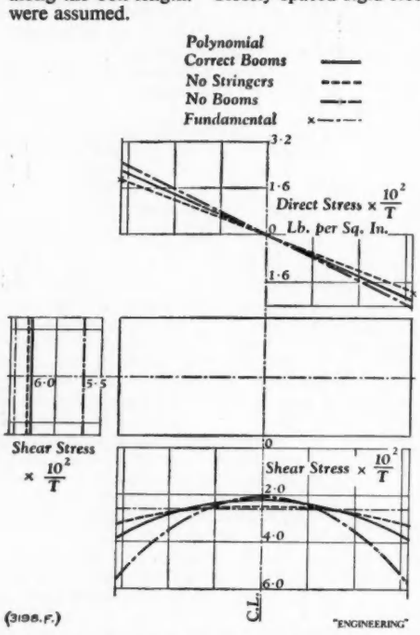


Fig. 5 Torsion constraint, chordwise variation.

General Constraint Effects.—In 1937 Ebner and Koller[7] investigated constraint effects generally by introducing systems of self-equilibrating internal end-load systems into the structure. The structure was idealised into discrete booms, shear carrying skins, and finite spaced flexible ribs. A strain-energy solution was used to determine the magnitude of these end-load systems.

Perhaps the most comprehensive work on constraint problems is that by Argyris and Dunne[13]. In this, Ebner and Koller's basic conception of internal end-load systems was applied generally to single or multi-cell, cylindrical or conical tubes, with or without cut outs. The work assumes closely spaced rigid ribs, which appears to be reasonably justified in many cases. The polynomial method mentioned later is a powerful one. However, like all approximate methods it obscures the mechanics of the solution. Improvement of the method by using polynomials of higher order is almost impossible because the individual terms are not orthogonal.

An attempt has been made in the shear-lag case by expressing the stress-distribution in terms of Fourier series across the cross-section with arbitrary variation in the spanwise direction. Using the Theorem of Minimum Strain Energy, and the methods of the Calculus of Variations leads to a solution which consists of a series of distributions the spanwise variation of which is of the form $e^{-ax}\cos(bx + c)$, where x is the spanwise co-ordinate. The solutions to the constraint problem of a uniform doubly symmetric rectangular box, as given by the fundamental, internal end-load and Fourier series methods are included in the paper.

THE SWEPT STRUCTURE

Before considering the problem as it affects the swept wing it is necessary to examine the types of structure used.

Rib Configuration.—Two basic configurations for a single cell wing are possible, depending upon the rib design. These are shown in Fig. 3. In the left-hand wing the ribs are placed approximately normal to the spars, so that away from the root the wing does not differ from an unswept equivalent. The right-hand wing has the ribs in a fore and aft direction. It will be realised that the rib direction has an important bearing on the constraint, and also on the approach to its estimation. The relative merits of the two methods of construction have been considered elsewhere,[19] and both are in common use.

Normal Rib Box.—It has been found possible to treat the case of ribs normal to the spars as an unswept box in which a triangular half of the first bay is rigid, as shown in Fig. 4. The method used is that of the internal end-load systems.[18] An example of the application of this method is given later.

Oblique Rib Boxes.—The approach to the case of fore and aft, or " oblique " ribs is dissimilar, since the wing as a whole differs from the unswept form. Wittrick and Thompson[14, 15] have attempted to extend the work of Argyris and Dunne to cover the swept case, but have found that the solution involves considerable difficulty. Hemp[16] has extended the elementary stress theories to include the swept box by referring the solution to oblique axes. These axes are defined by the span and rib directions. The obliquity entails a coupling between the direct and shear stress resultants in the skins, with a consequent complication in the solution. Good results have been obtained away from constraint sections.[19]

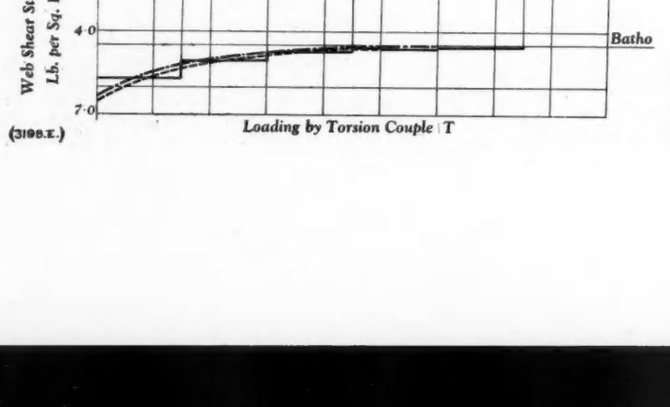


Fig. 6 (left) Torsion constraint, spanwise variation.

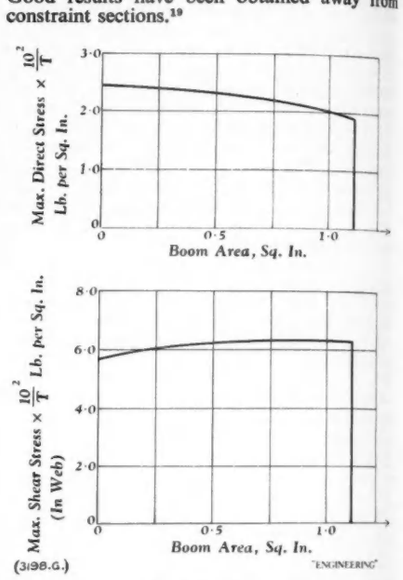


Fig. 7 Stresses due to torsion constraint, variation with boom area.

$b \times c = 400$ Sq. In.
Young's Mod. $= 10^7$ Lb. per Sq. In.
Shear Mod. $= 3{\cdot}85 \times 10^6$ Lb. per Sq. In.

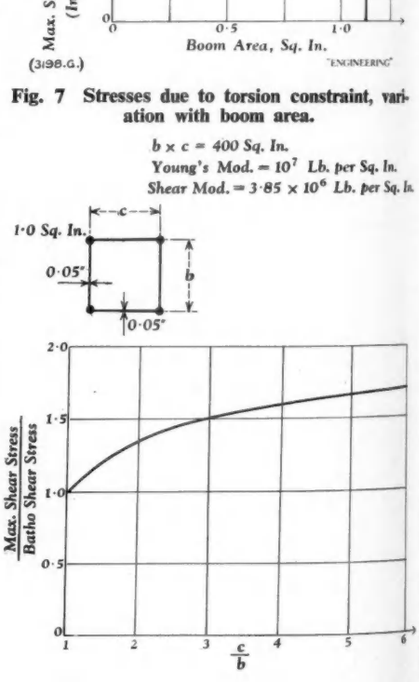


Fig. 8 (right) Torsion constraint, variation with ratio of sides.

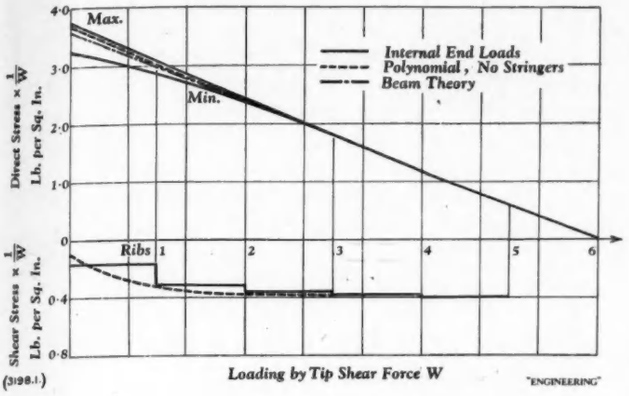


Fig. 9 (left) Stresses due to shear lag, spanwise variation.

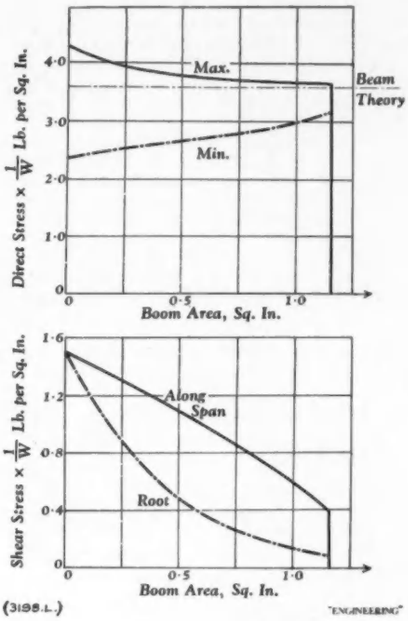


Fig. 11 (right) Stresses due to shear lag, variation with boom area.

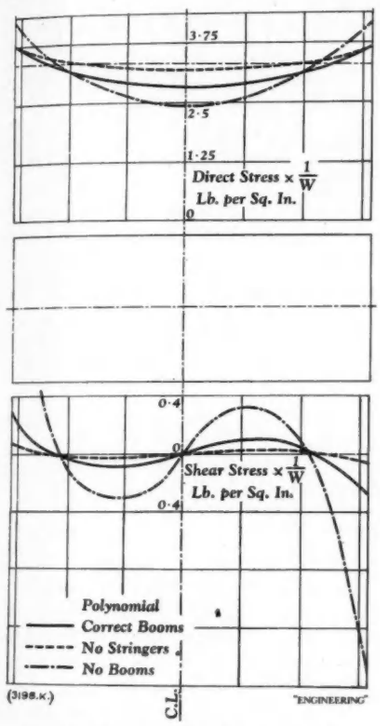


Fig. 10 Shear lag, chordwise variation.

The application of a method using internal end-load systems with a simple idealised structure of concentrated booms and shear carrying skins, is exceedingly difficult in oblique co-ordinates, due to the coupling terms previously mentioned. An attempt has been made[17] but the algebraic complication is enormous. The representation of the spanwise direct stress resultant in the skin, T_1, as a polynomial across the chord has been suggested by Hemp[21]. For example, assume:—

$$T_1 = C_1 + C_2 y + C_3 y^2$$

thus allowing T_1 linear and quadratic variation with y, the ribwise ordinate. C_1, C_2 and C_3 are functions of x, the spanwise ordinate. The stresses and strains are written in terms of the C_i and external loads, and the use of a variational strain energy method results in simultaneous linear differential equations for C_i.

If the spar boom area is zero, and the ribs are assumed rigid, the method is relatively simple. Inclusion of concentrated boom area complicates the solution markedly, including raising the order of the final differential equations. Allowing flexibility to the ribs, an effect shown to be of some importance away from the root of a swept box[19], also adds complication. Experimental results have indicated that the booms play an important part in the constraint effect. By neglecting certain second-order terms in C_2, and assuming rigid ribs, it has been found possible to make an allowance for the booms in a simplified solution. The neglected terms are zero for the cases of an unswept box, or a swept box with zero boom area.

The resulting solution takes the following form:—

$$K_{21}\frac{d^2C_2}{dx^2} - K_{22}C_2 - K_{23}\frac{dC_3}{dx} = -K_{24}Z$$

$$K_{31}\frac{d^2C_3}{dx^2} - K_{33}C_3 + K_{32}\frac{dC_2}{dx} = 0$$

Boundary conditions are given by:—

$$K_{21}\left(\frac{dC_2}{dx}\right)_{x=0} - K'_{23}(C_2)_{x=0} = -K'_{24}(M_1)_{x=0} - K_{25}(Z)_{x=0} + K_{26}(L_1)_{x=0}$$

$$K_{31}\left(\frac{dC_2}{dx}\right)_{x=0} - K'_{32}(C_2)_{x=0} = K_{35}(Z)_{x=0}$$

where M_1 and L_1 are bending and torsion couples referred to oblique axes and Z is the normal shearing force. K_{ij} and K'_{ij} are coefficients dependent upon the geometry and elastic properties of the structure.

For an unswept box:—

$$K_{23} = K_{32} = K'_{23} = K'_{32} = K_{24} = K'_{24} = 0$$

The resulting equations are then explicit in C_3 and C_3, C_2 giving torsion constraint and C_3 shear lag. Effects due to non-rigid ribs have yet to be considered. Examples of this solution for both swept and unswept boxes are included.

UNIFORM DOUBLY SYMMETRIC RECTANGULAR BOXES

The Unswept Case.—Details of the structure considered as an example for the calculation of the constraint effects in an unswept box beam are given in Fig. 4. The skin is reinforced by rigid ribs and spanwise stiffeners, concentrated booms being located at the four corners.

Torsion Constraint.—The root constraint stresses due to loading by a constant torsion couple have been calculated using the fundamental, internal end-load, and polynomial methods. In all, five cases have been examined: (1) Fundamental (displacement) solution: the box is idealised to have all the end-load carrying capacity located in the four corner booms, the skins carrying only shear. (2) Internal end-load solution: the box is idealised as for (1). (3) Polynomial solution: all the stringers are concentrated into the four booms. (4) Polynomial solution: correct distribution of end-load carrying material. (5) Polynomial solution: concentrated booms spread as stringers.

The spanwise distribution of stress for the first three cases is shown in Fig. 6. It can be seen that these solutions give a maximum shear stress occurring at the root of the spar webs, which is 45 per cent. greater than that predicted by Batho theory. The direct stress builds up to approximately 45 per cent. of the Batho shear stress. The internal end load method gives average values of the shears across the discrete bays.

The chordwise distributions at the root for cases (1), (3), (4) and (5) are shown in Fig. 5. These indicate the linear variation of direct and the parabolic variation of shear stresses across the section, as predicted by the polynomial solution. Fig. 4 also indicates the effect of varying the proportion of end-load carrying capacity located in the booms. This is shown more clearly in Fig. 7 where it can be seen that the larger the booms the lower the maximum direct and higher the maximum shear stresses. Thus, idealising the structure to suit the simpler theories results in an under-estimation of the direct stress build up. It also indicates that concentrated booms are desirable to reduce direct constraint stresses where these are critical. Fig. 8 shows the way in which the maximum direct and shear stresses vary with change in the width to depth ratio of a box, which has otherwise similar properties. There is no constraint when the sides are equal, but as one side is increased compared with the other, there is a rapid increase in the torsion constraint stresses.

Shear-Lag Constraint.—The internal end-load and polynomial solutions have been used to evaluate the shear-lag effect occurring when the structure is loaded by a normal shear force at the tip. In applying the internal end-load

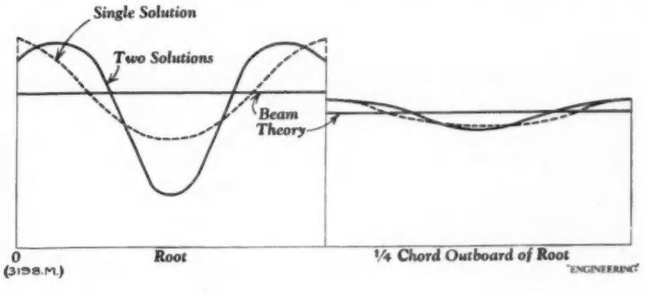


Fig. 12 Direct stress distribution in skin of completely unstiffened shallow box under shear, found by using a Fourier series approach.

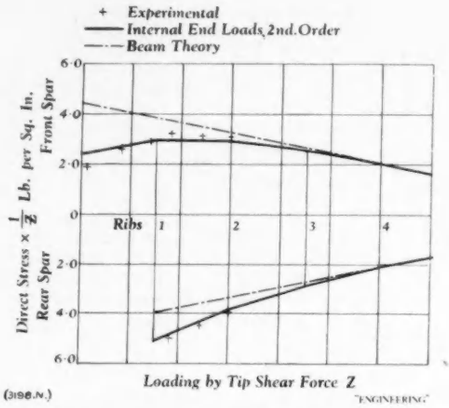


Fig. 13 Swept box: "normal" ribs, spanwise variation.

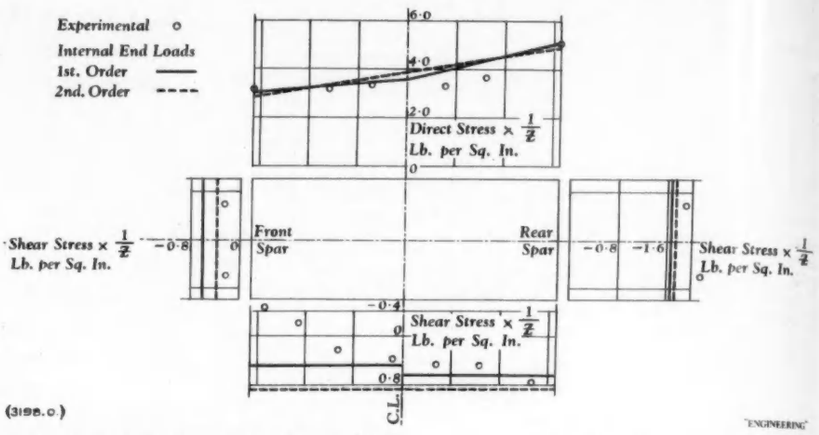


Fig. 14 Swept box: "normal" ribs, chordwise variation at rib 1.

method the structure has been idealised as shown in Fig. 4 with a concentrated boom in the centre of the chord. The polynomial solution has been applied to the same cases as in the torsion example.

Fig. 9 gives the spanwise stress variations and indicates that for the box in question the shear lag does not cause a very large increment in direct stress. Again the internal end-load method predicts an average shear stress across a rib pitch. The rate of die-away of the constraint tends to be greater than in the torsion case. Chordwise distributions are shown in Fig. 10. Since shear lag is a second-order effect, the direct stress distribution is parabolic and the shear stress cubic in form. The influence of varying the boom area can be seen in Fig. 11, indicating again that the greater the boom area the smaller the constraint direct stress. The skin shear stress is also less for large boom area as the skin has to contribute less to building up the end load. The maximum shear stress is constant along the box when there are no booms. Fig. 12 shows the results of a calculation by the Fourier series method for the simple case of the completely unstiffened box which is sufficiently shallow for web effects to be ignored.

The Swept Case—Ribs Normal to Spars.—The box considered is similar to that used for the unswept examples, except that a triangular half of the root bay is built in. Loading is by a normal shear force located on the centre-line at the tip. Using the internal end-load method of solution, two different idealisations of the structure have been made. These correspond to the torsion and shear lag examples used above. The spanwise direct stress distribution obtained by using the shear-lag idealisation shows a large variation from the beam theory. This is presented in Fig. 13 which also shows the good agreement obtained with experimentally derived values. Fig. 14 shows the chordwise distributions at the first rib. Experimental points are shown together with the predictions given by both forms of idealisation. The shear-lag effect is seen to be relatively small. Flexibility of the first rib has been found to be of little importance in this instance.

Ribs Fore and Aft.—The box used for this example is detailed in Fig. 15. This box also has concentrated booms at the four corners. Two loading cases are considered: (1) a pure bending couple along the spanwise axis—M_1; (2) a normal shear force on the centre-line at the tip—Z.

A comparison between the spanwise direct strains given by the first-order polynomial solution and those obtained experimentally at a rib-wise section near the root are shown in Fig. 16. The theoretical effect of distributing the boom area across the skin is also shown. In the case of the pure bending couple the maximum direct strain is approximately twice the mean. These examples clearly show the importance of root constraint in a swept wing. The necessity of making the correct allowance for concentrated boom area is also indicated.

PRACTICAL EXAMPLES

In order to illustrate the practical implication of root constraint effects, two further examples are now given.

60 deg. Sweptback Wing.—Geometrical details of a representative 60 deg. sweptback wing are shown in Fig. 17. The-load carrying structure

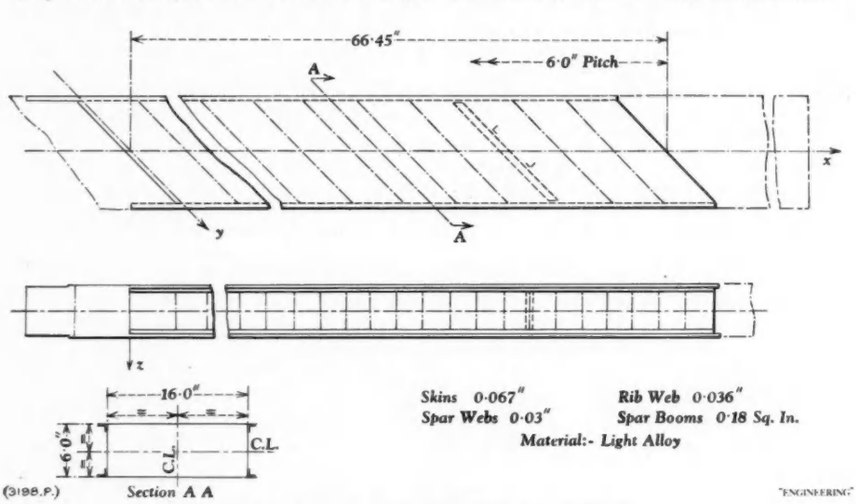


Fig. 15 45 deg. swept single-cell box, structural details.

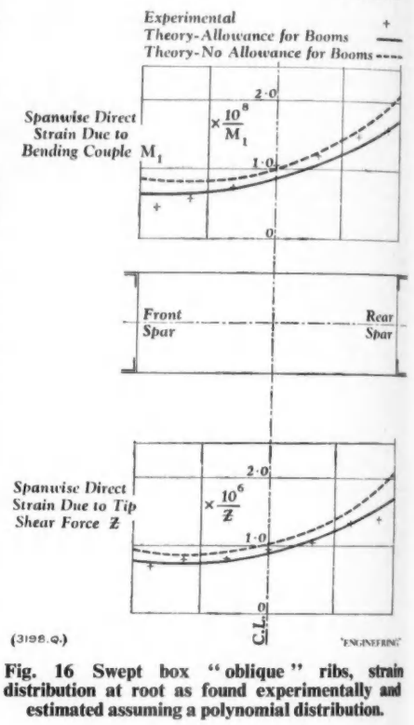


Fig. 16 Swept box "oblique" ribs, strain distribution at root as found experimentally and estimated assuming a polynomial distribution.

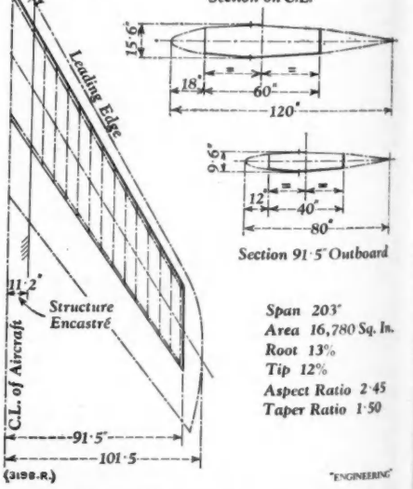


Fig. 17 Representative 60 deg. sweptback wing, which has been subject to test.

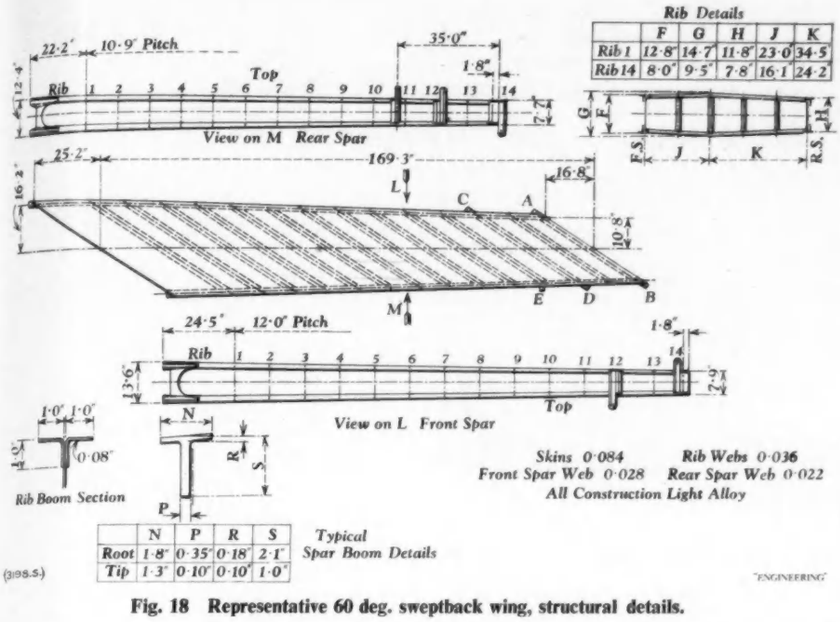


Fig. 18 Representative 60 deg. sweptback wing, structural details.

of this wing, which is detailed in Fig. 18, has been subjected to a comprehensive series of tests under simple types of loading[20]. In an attempt to ensure full fixation the root was built into reinforced concrete. The experimental strain distributions in the skins and webs at a section midway between rib 1 (root) and rib 2, when the wing is loaded by a tip shear force, are given in Fig. 19. Comparison is made with the predictions of the first-order polynomial solution, with boom allowance. The direct strains are in good agreement except at the extreme rear spar, where there was in all probability a warping of the boom within the concrete. The comparison with the web shear strains is reasonable, but while the skin shears agree on the centre-line, the need for a more elaborate theory, possibly including rib flexibility, is apparent. The importance of correct allowance for the booms is emphasised by the curve calculated assuming the booms to be distributed. It should be noted that the rear spar carries nearly all the normal shear load at the root, which is positive evidence of the importance of constraint effects to the aeronautical engineer.

The Britannia Bridge.—In comparison to the 60 deg. sweptback wing the second example shows negative results. The magnificent engineering feat, the Britannia Tubular Railway Bridge spanning the Menai Straits, is an example of a large-scale box beam. Made of wrought iron, its design and erection, under the supervision of Robert Stephenson, has been fully described by Clark.[1] The bridge consists of two box beams, placed side by side, each carrying a single track. It has two main spans each of approximately 460 ft., and two subsidiary spans, each of 230 ft. The maximum depth of the tube occurs at the centre, or Britannia Tower, the cross-section of one tube at this point being shown in Fig. 20. Since the tubes are continuous across the Britannia Tower, which carries only shear loads, there will be a shear-lag effect at this point. In order to apply the polynomial solution, the section of the beam has been idealised as shown in Fig. 20.

The direct and shear stresses in the tube, under its own weight, using a unit load based on the values given by Clark, are shown in Fig. 21. It will be seen that in the case of direct stress the vertical scale is much enlarged to show the cross-sectional variation. There is a second order effect due to the distributed load, which is not a constraint effect, and is normally ignored, and which causes a cross-sectional variation of 0·6 per cent. of the beam theory. The shear-lag effect only amounts to 0·08 per cent. of the beam-theory stress. While the shear stress variation is greater, the effect is to reduce the maximum value. This example shows that on structures of the size, proportion and loading of the Britannia Bridge, shear lag is of no importance. It is interesting however in that it serves to emphasise the difficulties encountered in aircraft structures.

CONCLUSIONS

In summarising the examples given in the paper it can be said that constraint effects are of considerable importance in the design of aircraft-wing structures. The unswept examples indicate that torsion constraint is the more important. However, it should be pointed out that as the skin width to thickness ratio tends to be equal to the web depth to thickness ratio, torsion constraint effects tend to zero, and shear lag is dominant, particularly if the concentrated boom area at the spar webs is small. An example of this was the Bristol Brabazon wing.

The necessity for making the correct distribution of end-load carrying capacity has been demonstrated. Root constraint in a swept wing is very important, causing a considerable build-up in the stresses at the rear spar. The role of concentrated booms at the edges in reducing constraint stresses, especially in the swept case, has been illustrated. Further investigation is required to establish the importance of rib flexibility in evaluating the swept-wing root constraint.

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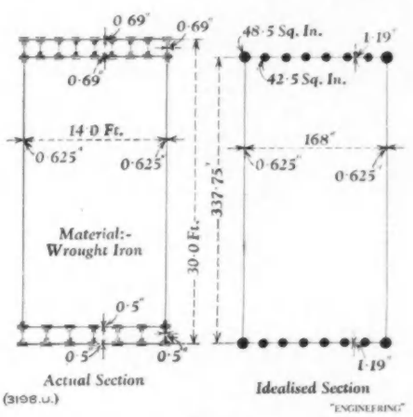

Fig. 20. Britannia Bridge. Cross-section of one tube at centre tower.

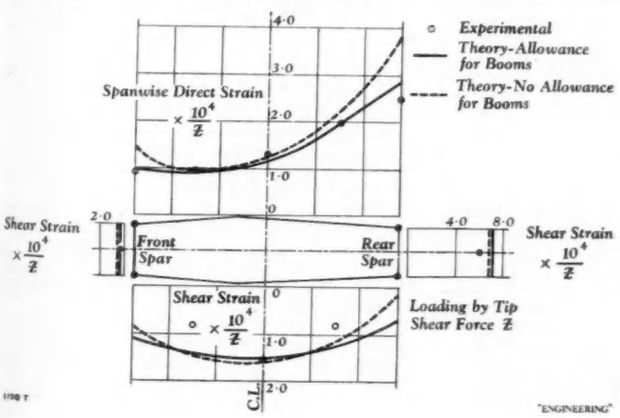

Fig. 19 (left) 60 deg. sweptback wing strain distribution at root, as found experimentally and according to theory.

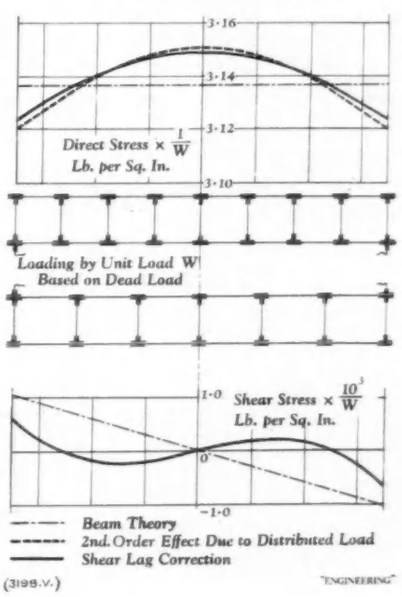

Fig. 21 (right) Britannia Bridge. Stress distribution at centre tower.

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CALIBRATING DYNAMIC BALANCING MACHINES

GRAPHICAL METHOD NOT EMPLOYING PREVIOUSLY BALANCED SPECIMENS

*By J. A. Macinante**

The article describes a method of calibrating dynamic balancing machines of the resonance type by a simple geometrical construction based on observations of controlled experiments. The calibration determines the relation between the indications of the machine and the unbalance of test rotors, and hence the sensitivity of the machine can be deduced in terms of the minimum unbalance that can be detected. The special feature of the method is that it enables the calibration to be made without the use of a rotor specimen previously balanced to a high degree of accuracy.

With the recent introduction of tolerances for the dynamic balance of rotating components it has become important for both works and inspection to know whether a given balancing machine can detect a certain permissible amount of unbalance, and if so, to know the machine reading corresponding to this unbalance.

The necessary information is obtainable from a calibration of the machine reading (bearing displacement) versus the unbalance (mass × radius) in a chosen plane normal to the axis of rotation of the component. It is not sufficient to add a known mass at a known radius and relate this "added" unbalance to the machine reading, because the true unbalance is the vector sum of the added and the initial or uncorrected unbalance.

The procedure described below was used by the author to calibrate two dynamic balancing machines of the resonance type, which were set up for balancing certain rotors and gears for marine turbines. It consists simply in combining vectorially a sequence of values of added unbalance with the initial unbalance which is found by the simplified graphical method described by Somervaille.†

This article refers to resonance machines, although the method is suitable for any application where a certain unbalance is to be applied in a given plane. In the usual practice with resonance machines the component is first driven to a speed above the bearing resonance speed and the drive disengaged. The right bearing is then unclamped so that it is free to vibrate on its flexible support. As the speed decreases the bearing displacement passes through a maximum at resonance and a reading is taken for this maximum. All readings are taken at resonance, and hence at the same rotational speed of the component. One or other of the balancing procedures is used to evaluate the required correction, and the necessary masses added in a right balancing plane until the right bearing reading is sufficiently reduced. The procedure is repeated for the left end and, since modification of the balance at one end has an effect on the other, the right end is checked and if necessary adjusted. The procedure is repeated until the balance is satisfactory.

The calibration procedure is given in detail for the right end of the component, for which it is required to find the relationship between right bearing reading and unbalance in the right balancing plane. The procedure is as follows:

(i) With the left bearing clamped, the right bearing reading is observed firstly in the condition as found, then with a test unbalance (mass × radius) T_1 placed successively in three positions A, B, C, spaced 120 deg. apart in the right balancing plane. Let the four readings so obtained, each based on several runs, be respectively u, r_a, r_b, r_c. Then (after Somervaille) three lines OA, OB, OC of length u (Fig. 1) are drawn to any convenient scale, representing the successive angular positions of T_1. From A, B, C, arcs of radii r_a, r_b and r_c respectively are drawn to the same scale. In practice the arcs will seldom intersect at a point because of experimental errors, and a mean position (D) may be estimated as in Fig. 1.

The unbalance U requiring correction is in the direction shown by the broken line and of magnitude

$$U = T_1 \left(\frac{u}{t}\right).$$

(ii) A series of test unbalance values T_2, T_3, etc., is then added in turn at a particular position, such as A in Fig. 2, and the corresponding bearing readings r_2, r_3, etc., observed.

The true unbalance values corresponding to T_2, T_3, etc., are R_2, R_3, etc., which are the resultants of the added and initial unbalances as shown in the vector triangles in Fig. 2. This second step is shown separately for clarity, but obviously the whole construction could be done on one diagram by setting out the unbalance vectors (Fig. 2) on the lines already drawn for the diagram of bearing displacement readings (Fig. 1).

Three additional values of bearing displacement reading and true unbalance are available from the earlier observations, by combining U with T_1 at its three positions, which gives true unbalance values R_a, R_b and R_c for which the readings r_a, r_b, r_c were observed. Finally, the initial reading u, corresponding to the true unbalance U with no test mass added, was also observed previously. The test observations are summed up in Table I.

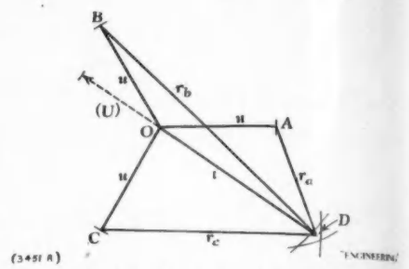

Fig. 1 To find the true initial unbalance, the first vector diagram is constructed by observing the effect of a known unbalance added in three successive positions.

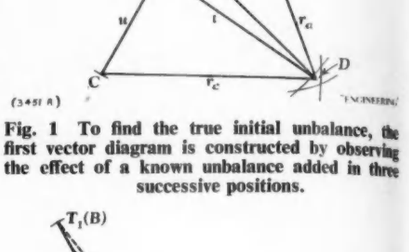

Fig. 2 A series of unbalance values is added at one position and the true values determined from the vector triangles obtained.

TABLE I.

Added unbalance	O	T_1(A)	T_1(B)	T_1(C)	T_2	T_3, etc.
True unbalance	U	R_a	R_b	R_c	R_2	R_3, etc.
Bearing displacement reading	u	r_a	r_b	r_c	r_2	r_3, etc.

The bearing displacement readings are plotted against the true unbalance values, and the allowable reading for a specified maximum unbalance is taken from the graph. The procedure is then repeated working from the left end of the component.

Clearly, the practice of simply relating the bearing reading with a series of added unbalances may be seriously in error if correction is not made for initial unbalance. The true unbalance corresponding to a given added unbalance T_n lies within limits ($T_n \pm U$), the value depending upon the (arbitrary) angular position at which the test masses are added in relation to the position at which initial balance correction is required.

The above method, involving evaluation of the initial unbalance, is more positive and takes less time than the alternative procedure of attempting to correct all significant initial unbalance for the purpose of adding test unbalances on a "perfectly balanced" component.

The calibration of any resonance-type machine applies specifically to the machine as set up for a particular component, and for unbalance at a given axial position on that component. This is because the bearing displacement reading at resonance depends on the weight, weight distribution and axial position at which unbalance is effective, as well as on the stiffness and damping of the bearing assembly, and the overall magnification of the displacement indicating system as set up for the test.

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* Division of Metrology, Commonwealth Scientific and Industrial Research Organisation, Australia.

† Somervaille, I. J., ENGINEERING, vol. 177, page 241 (1

CANADIAN VACATION EXPERIENCE FOR STUDENTS

RECIPROCAL ARRANGEMENTS BEING ESTABLISHED

During the past few years it has been possible for many British undergraduate students to go to Canada for practical experience during their long vacations under the sponsorship of the International Association for the Exchange of Students for Technical Experience (I.A.E.S.T.E.), but the number of Canadian students able to participate in this programme has been small.

The British students are received in Canadian industries for periods of eight to 12 weeks and they receive the same rates of payment as Canadian students engaged upon similar work, namely between 250 and 300 dols. per month. A careful student can therefore, if he so desires, often recover a part, if not all, of the travelling expenses connected with his visit.

Many Canadian undergraduates make initial inquiries of the Engineering Institute of Canada, who are sponsors of the I.A.E.S.T.E. programme, but when they find that it is necessary for them to cover their own travelling expenses to Britain, or some other country, it is not possible for them to proceed further with their desire to take part. This condition is dictated by the necessity for the large majority of Canadian undergraduates to earn sufficient during the summer vacation to enable them to cover their university fees and maintenance, etc., on return to the university. Very few Canadian students are in receipt of Government assistance.

The average undergraduate in Canada works in industry for a period of about four months each year and after meeting all his expenses during this period often returns to the university with a credit balance of perhaps 800 or 1,000 dols. If, therefore, he goes abroad for experience during the vacation following the penultimate year of his course, he will find himself in financial difficulties on returning to his studies unless his parents are able to help him. Practical experience in industry abroad under I.A.E.S.T.E. will provide a Canadian student with sufficient to cover his cost of living expenses and enough pocket money to meet his day-to-day needs, but it will not cover his transportation costs, nor can he expect to return with a credit balance if he makes the best use of the opportunity of seeing something of another country.

Mr. J. Newby (Superintendent of Vacation Studies at the Imperial College of Science and Technology and secretary of I.A.E.S.T.E. in Great Britain) has recently completed a short visit to Canada during which he raised with academic and industrial interests the possibility of finding ways and means of making it easier for Canadian undergraduates to come to Britain for experience during the summer of 1957. Several of the industries in Canada have agreed to support a plan which will have as its object the establishment of some Industrial Travelling Bursaries to assist selected students to go abroad who could not otherwise do so. It is intended that these bursaries will be named after the industry contributing; they will be tied to I.A.E.S.T.E.'s programme and may cover one-half or two-thirds of the student's total transportation costs from home to his place of work.

The United Kingdom Trade Commissioner in Montreal recently convened a meeting at the Engineering Institute of Canada of leading industrial organisations which had not yet received students under the I.A.E.S.T.E. programme. It is anticipated that many more places will be available during the summer of 1957 for British undergraduates at the end of their penultimate year of study. It is to be expected that among the British students anxious to go abroad for practical experience there will be many who, although otherwise qualified and worthy, will not be able to participate because they are unable to raise sufficient funds to cover the cost of transportation. It has been suggested that consideration might be given to the possibility of establishing a loan fund to provide travelling assistance for British undergraduates, repayment to be made on their return.

Whilst the value of this programme in fostering Commonwealth and international understanding and goodwill amongst the undergraduates participating cannot be too strongly emphasised, there is the additional advantage to the student of broadening his education by travelling abroad and mixing with the people of other nations. Mutual understanding breeds mutual respect. Such opportunities for living and working in other countries, in most cases, can occur only once in a life-time and cannot, in any sense, be equalled by travelling abroad as an ordinary tourist.

* * *

NATIONAL BUREAU OF STANDARDS, U.S.A.

At the annual conference of the Institute of Weights and Measures Administration held in Bournemouth recently, Mr. W. S. Bussey, Chief Officer of Weights and Measures, National Bureau of Standards, Washington, D.C., presented a paper on the United States system of weights and measures administration. The paper also described the organisation of the Bureau of Standards, the activities of which are very similar to those undertaken in this country by three separate bodies: the Standard Weights and Measures Department (until recently the Standards Department of the Board of Trade), the British Standards Institution, and the National Physical Laboratory.

Throughout the Nineteeth Century the care and maintenance of the United States standards was the task of the Coast and Geodetic Survey of the Treasury Department. In 1901 the small sub-division known as the Office of Standard Weights and Measures was re-named by Congress as the National Bureau of Standards, but it remained under the Treasury until 1902 when it was transferred to the newly formed Department of Commerce and Labour. In 1913 when that Department was divided the Bureau was assigned to the Department of Commerce.

The functions and activities of the Bureau have steadily widened over the years and now extend far beyond the original duty of the custody, maintenance and development of national standards of measurement. They now include: (*a*) the provision of means and methods for making measurements consistent with the standards for use in scientific investigation, engineering, manufacture and commerce; (*b*) the development of, and the testing of methods for, the testing of materials, mechanisms and equipment; (*c*) the testing of supplies to government departments and independent bodies; and (*d*) co-operation with other agencies and organisations for the establishment of standard practices, codes and specifications. A better picture of the ramifications of the organisation and its functions can be gained from a description of the organisation of the Bureau itself.

The National Bureau of Standards is administered by a director and four associate-directors, with a director for the Boulder Laboratories. The associate-directors have specific responsibilities in the fields defined as chemistry, physics, testing and planning. The staff number approximately 2,750, of whom about 2,150 are located at Washington. In addition to the Washington headquarters, housed in 30 major buildings and 71 other structures on a site in the residential area of the city, there are 25 field stations scattered throughout the United States and in foreign countries. Recently completed and occupied is the large installation consisting of three permanent structures in Boulder, Colorado, and named the Boulder Laboratories.

The scientific activities of the Bureau are grouped in "divisions," each headed by a division chief. Twelve divisions are located in Washington; these are Electricity and Electronics, Optics and Metrology, Heat and Power, Atomic and Radiation Physics, Chemistry, Mechanics, Organic and Fibrous Materials, Metallurgy, Mineral Products, Building Technology, Applied Mathematics, and Data Processing Systems. At the Boulder Laboratories are located the divisions of Cyrogenic Engineering, Radio Propagation Physics, Radio Propagation Engineering, and Radio Standards. Each division is divided into sections, each administered by a section chief.

The organisation also includes an assistant director for administration and several administrative and service divisions, with functions in the fields of budget, accounting, audit, personnel, supplies, shops, plant, management, planning and security. Serving as part of the director's office, yet under the administration of an associate-director, are two offices known as the Office of Basic Instrumentation and the Office of Weights and Measures.

* * *

HINTS ON OVERSEAS TRAVEL

The Council of British Manufacturers of Petroleum Equipment feel that since most of their members are willy-nilly globe-trotters they should provide them with the A.B.C. of this not so simple technique. Two booklets have been published and circulated with the chairman's report on the work of the Council in the past year. Both are based on the personal experience of members' representatives and contain much practical guidance and valuable hints. For example, there are clothing lists including items such as "12 socks (thin nylon or terylene recommended)" "one bush shirt" and "one dark suit for dinner wear or dinner suit"; how to get a pre-departure briefing, with a bibliography on sources of information; who to see on arrival ("preliminary contacts"); mode of travel; health regulations and medicines to take; what not to drink (water can be most unsuitable, if not positively harmful). These and a host of other tips are given quite separately for the two main hunting grounds of petroleum plant engineers, the Middle East and the Caribbean.

These two booklets are expertly compiled and easy to consult. If the advice on clothing requirements before department is ignored, the metric measurements equivalent to English sizes are given in an appendix. Recommendations on hotels and restaurants—in countries for which there is, alas, no *Guide Michelin*—could be most valuable and probably the product of much bitter trial and error.

The Council of B.M.P.E. are to be congratulated on their enterprise and the solicitude they show towards their members. Beneficiaries need not be confined to petroleum plant engineers.

* * *

USES OF DIESEL ENGINES

Two films in colour have been made by R. A. Lister and Company, Limited, Dursley, Gloucestershire, showing the uses of Diesel engines. The first is confined to railway work and depicts the use of a Diesel-electric locomotive in shunting and marshalling. The second, entitled "Diesels in Industry," covers a wider range and shows several examples of Lister-Blackstone engines employed in a limestone quarry, a telephone exchange, a portable power house, etc. "Railway Marshalling" runs for 24 minutes and "Diesels in Industry" for 32; both films can be borrowed from the company.

Book Reviews

ASSEMBLED DATA ON ATOMIC ENERGY

Research Reactors. (6.50 dols.; 49*s.*) **Reactor Handbook: Physics.** (12 dols.; 90*s.*) **Reactor Handbook: Engineering.** (15 dols.; 112*s.* 6*d.*) **Reactor Handbook: Materials.** (10.50 dols.; 79*s.*) **Neutron Cross Sections.** By DONALD J. HUGHES and JOHN A. HARVEY. (12 dols.; 90*s.*) **Chemical Processing and Equipment.** (6 dols.; 45*s.*) Prepared by the United States Atomic Energy Commission. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, U.S.A.;* and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.4.*

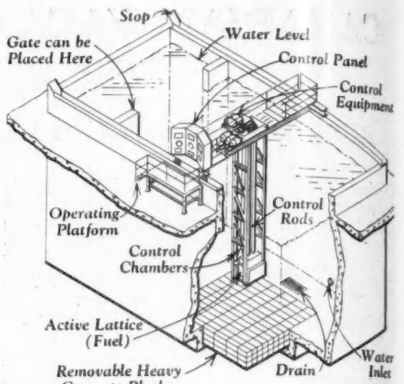
This elegant and important set of volumes* is an encyclopaedic collective work by a large number of authors, many of whose names are household words in the nuclear energy field, and comprises contributions from most of the great nuclear energy laboratories in the United States. The volumes differ considerably from each other, and are aptly designated by the sponsors in a sub-title " Selected Reference Material on Atomic Energy." Although the editors of the three volumes which comprise the *Reactor Handbook* explain that the work is not a handbook in the normally accepted sense, it can fairly be said that the whole six volumes complement each other and in reality constitute a substantial single reference work. However, each volume is, despite some inevitable overlapping, effectively self-contained and properly described by its title, a great advantage for those with specialised interests. An attempt is made, therefore, in this review to describe the nature of the contents of each volume in general terms.

The six books as they are now presented to the public by the present publishers were specially prepared to serve as a background to the papers presented to the United Nations at Geneva. The three *Reactor Handbook* volumes have their origin in a classified version which was prepared in 1952, and published in 1953, for use in United States Atomic Energy Commission projects, mainly using material which had already been published in report form within the U.S.A.E.C.

* Also available in paper backed editions from the United States Government Printing Office through H.M. Stationery Office, Kingsway, London, W.C.2. *Research Reactors* (17*s.*); *Reactor Handbook: Physics* (36*s.* 2*d.*); *Reactor Handbook: Engineering* (46*s.* 9*d.*); *Reactor Handbook: Materials* (29*s.* 9*d.*); *Neutron Cross Sections* (29*s.* 9*d.*); *Chemical Processing and Equipment* (17*s.*).

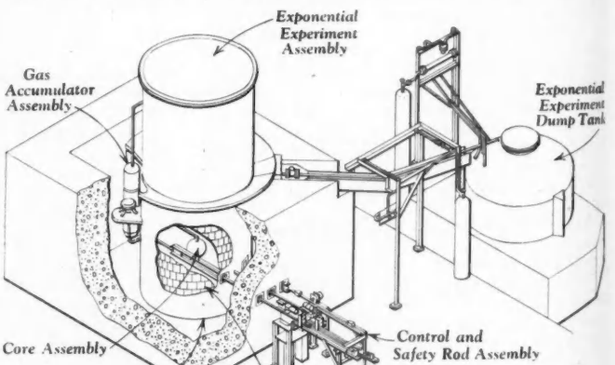
The present version was compiled from this by deleting material still in the classified category at the time of preparation (early 1955) and re-editing to the minimum degree necessary to give the work continuity and a satisfactory appearance. It is an unfortunate chance of the timing of this process that much material may have been deleted from the handbook volumes which was still classified in early 1955 but which would have come within a declassifiable category by the time of the Geneva Conference in the summer of the same year. However, this and the fact that these volumes contain no material of later date than the end of 1952 must not be counted too heavily against publication at this time, for it is the first large-scale issue of nuclear energy technological data in collected form and it may well be some time before it becomes worth while to prepare a more up-to-date edition. Rather they should be viewed as providing, together with the other three books, the foundation for a study of the papers now being published in the United Nations Geneva Conference proceedings, and as a condensed reference source for a large fraction of the work completed up to 1952; for indeed, there are extensive references and selected reading lists at the end of most chapters, and source references are given with nearly every table and figure.

The volumes which will have the greatest appeal to engineers will probably be *Research Reactors* and *Reactor Handbook: Engineering*, for it is in these two that the greatest amount of design detail will be found. In *Research Reactors*, which contains material up to early 1955, are described six representative types of research reactor, ranging in heat power output level from one watt to thirty million watts. They are all of the thermal neutron type and include the most important research reactors of this class at present in use in the United States. The descriptions given are comprehensive but compact, systematically laid-out and lucid, covering in summary form the important aspects of design, including control systems and shielding, operating experience and performance data. The experimental facilities available are described, as regards both the mechanical details and neutronics. The whole volume is profusely illustrated by clear dimensioned-drawings and excellent photographs of detailed items of construction and equipment. The longest single chapter provides a remarkably complete study of the important materials testing reactor (MTR) and contains a careful discussion in the section on design calculations of the most critical considerations in the reactor design, including neutronics, heat transfer, and an interesting analysis of the shielding problem. The Materials Testing Reactor at the National Reactor Test Station, Idaho, is shown in the illustration on the left below. There is a good account of the control and instrumentation considerations, and a short study of the general problem of putting experimental test circuits, or " loops," into the neutron flux of so powerful an irradiation tool. The design of loops is a special subject in its own right and no doubt will give rise to a manual of its own when sufficient experience of their design and operation has been acquired, but the importance of even such a brief discussion as given here will be appreciated by the power-reactor designer and the metallurgists and chemists working with him; for in this country, as in America, further progress with the design of advanced types of power reactor will come to depend increasingly upon loop tests conducted in powerful materials testing reactors such as those of the heavy-water moderated PLUTO type now being constructed at Harwell and Dounreay or the light-water moderated MTR type described. There is a short discussion on the reasons for choosing light-water moderation rather than heavy, the principal one being that the light-water type gives a much higher fast neutron flux in the experimental volume for the same thermal neutron flux intensity and reactor power. This is of importance for testing non-fissile materials in which the main damage factor is the fast-neutron flux, but it is of much less importance for tests on fissile material in the



Bulk shielding reactor (BSR) at Oak Ridge, U.S.A. The light-water moderated enriched-fuel pool reactor provides high thermal-neutron flux, accessibility and versatility at low cost.

Materials testing reactor (MTR) at the National Reactor Test Station, U.S.A. To test the behaviour of materials under heavy irradiation, experimental circuits or loops may be inserted in the reactor.



Layout of low-power (1 watt) solution-type light-water moderated " water boiler " reactor from which later schemes for heavy-water moderated homogeneous power reactors have been derived.

form of highly rated fuel elements, which are themselves sources of fast neutrons and in which in any case the damage resulting from the irradiation is mainly due to internal fission-fragment action.

The other reactors described in this volume are of less direct consequence to the nuclear power engineer since they are primarily research tools for general pile neutron experiments, such as the well-known Brookhaven graphite pile, the Argonne CP5 heavy-water reactor (from which the design of the British DIDO and PLUTO reactors derive their origin) and the light-water moderated solution-type low-power homogeneous " water boilers " from which stem the general ideas for the heavy-water moderated homogeneous power reactors now being studied. A low-power (1 watt) solution-type reactor is illustrated on the right at the foot of page 176. However, the so-called Bulk Shielding Reactor (BSR), better known as a swimming-pool reactor (as demonstrated by the United States delegation at Geneva) is an important tool for the engineering design of reactor shielding and is of topical interest in this country because of the construction of a similar facility (LIDO) at Harwell and of the A.E.I. reactor MERLIN which will be similar in many respects. A bulk shielding reactor operating at the Oak Ridge National Laboratory, U.S.A., is shown diagrammatically at the top of the preceding page. In general, the wealth of design detail provided in describing these research tools cannot fail to be of interest and value to designers of other reactors of almost any type.

The *Engineering* volume of the *Reactor Handbook* is largely concerned with the presentation of a great deal of tabulated and graphical data, much of which has been amassed during the course of investigations into the feasibility of various nuclear power schemes. In addition, there is much data which is complementary to the volume on *Research Reactors*, particularly as regards the heat transfer properties of water-cooled and gas-cooled systems, and also information drawn from experience with the various production reactors. Thus the section on light and heavy water-cooled systems is by far the largest, occupying nearly a quarter of the volume. Throughout the book the attempt is made to generalise the data as much as practicable and to demonstrate the application of the information to a wide variety of possible reactor schemes.

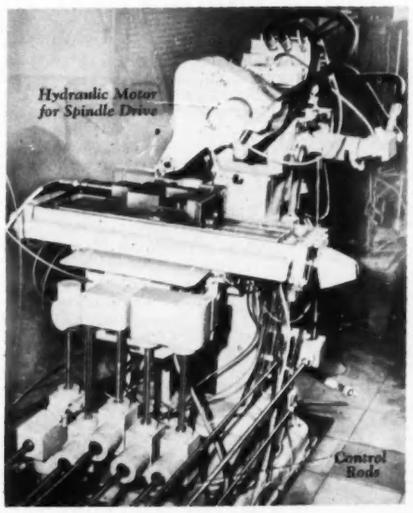
There are six main chapters referred to particular classes of reactor scheme, of which three chapters deal with reactors using solid fuel elements with either water, liquid-metal or gas coolants, the remaining three dealing with liquid-fuel systems using water, liquid metals and fused salts as the fuel carrier. These subdivisions are clearly very necessary since the technologies which contribute to the various schemes are quite different in nature. The range of subject matter covered for each type is necessarily wide, and includes neutronics, hydrodynamics and heat transfer, which receive considerable attention, and also corrosion, metallurgical and materials technology data. Apart from the systematic presentation of a great deal of physical data, ranging from basic properties of materials to the pressure drop in pipe bends, there is much textual matter illustrating the application of the data to representative problems arising in the design of a reactor system. Each of the six chapters devoted to reactor types includes a review of the feasible types of system which could be considered for obtaining mechanical power, by way of the various thermodynamic cycles, from the class of reactor being considered. There is very little mention of fast-fission reactors except for a few speculative paragraphs in the chapter on fused-salt systems.

Where the design of auxiliary mechanical equipment must be of a specialised nature, for example, in the design of valves, pumps and heat exchangers for liquid-metal or fuel-solution systems, some engineering design detail is provided, although in fact the improvements in techniques of this sort since 1952 have been so marked that much of the detail is rather outdated; however, the general principles indicated still apply. There are a few interesting speculative designs for prime-mover equipment for possible application to high-temperature high-pressure gas-cooled reactors using gas-turbine equipment, with the rotating parts mounted on pressure-fed gas lubricated bearings, but apart from these there is very little mechanical design detail provided in the *Reactor Handbook* appertaining to power conversion equipment.

The subject of reactor stability and control is spread out somewhat between three volumes. The main theoretical basis is dealt with fairly deeply but with a minimum of explanatory text in the *Physics* volume, and a chapter in the *Engineering* volume deals with the problem in more practical terms from a general viewpoint. These contributions are supplemented by notes pertinent to the kinetic behaviour of particular reactor types in the relevant chapters in the *Engineering* and *Research Reactor* volumes. The question of the interaction of a power plant with the reactor system is not dealt with to any extent, the main concern being the internal kinetics of reactors.

Following the notes on reactor kinetics in the *Engineering* volume is a valuable survey of radiation-detection instruments suitable for nuclear reactor application together with a short account of the electronic equipment appropriate to pulse counting and continuous ionisation current measurement as used in reactor control systems. No attempt is made to deal with the electronic circuits in any detail; this, of course, forms a complete subject in itself. The electronic material here is mainly in the form of block diagrams and skeleton circuits with concise and lucid notes in the text.

There is a certain amount of mechanical design detail in the chapter on remote viewing and manipulation, and this is complementary to the major portion of the sixth volume in the series, of which over three-quarters is devoted to laboratory equipment. Taken together, these two sections provide a wide review of equipment of all types required to handle highly radioactive items within appropriately sealed and shielded chambers. The value of the *Chemical Processing and Equipment* volume, which contains material up to late 1954, is somewhat reduced so far as readers in this country are concerned in that it naturally deals with many proprietary items of American manufacture, but it is so beautifully illustrated with line drawings and composite photographs that the detailed construction is revealed as clearly as could be devised, when it is considered that some 125 items of equipment are described. Of special interest to mechanical engineers will be such items as remotely controlled machine tools, including two lathes, a milling machine, shown below, and a drilling device; of special interest to the metallurgical engineer are remotely operated mechanical test machines, a profile recorder and a controlled-atmosphere welding chamber; and the chemical engineer concerned in work on the experimental scale will doubtless be interested in such items as a peristaltic pump, a bellows pump, various remotely operated valves and numerous containers for radioactive fluids.



The machining of radioactive metals calls for the use of remotely controlled tools like this milling machine at Oak Ridge, U.S.A.

The two volumes also combine to provide a wealth of detailed information on the design of hot laboratories and caves together with informative descriptions of their associated remote viewing and manipulating equipment, the latter ranging from relatively simple through-the-wall tong equipment to an electronically controlled master-slave manipulator with a force-reflecting servo-system. Usually literature references are given which will enable much more detail on particular items of equipment to be obtained, including the serial numbers of drawings prepared by the U.S. National Laboratories.

The chemical processing of fuel elements which have undergone their term of service in a nuclear reactor is an integral part of any reactor project, and the chemical engineer will find much of interest in the excellent 40 page account of the Idaho Chemical Processing Plant which forms the first part of the *Chemical Processing and Equipment* volume. The purpose of this plant is to separate unconsumed uranium, mostly uranium 235, from the fission products and the aluminium which is used both as a rolled-on fuel element cladding and for alloying with the enriched uranium to form the MTR-type of fuel element. Unlike the British plants at Windscale, the production of plutonium is not an objective of this plant; such plutonium as is formed from uranium 238 remaining in the original enriched uranium is separated from the uranium along with the fission products and rejected, possibly for later recovery in a by-product plant. This informative article provides descriptions and diagrams of plant layout and important mechanical details of plant equipment such as dissolvers, pumps and control gear as well as flow sheets and other process data. The problems of radioactivity and criticality, which enforce special considerations of decontamination, shielding and safe geometry upon the plant and its components, are discussed as fully as could be expected in a relatively short article. This plant is of topical interest in this country because of the similar processing requirements which will shortly arise with the new DIDO-class reactors now under construction.

The design of both reactors and fuel processing plant, especially the former, requires a knowledge of the properties of a wide range of materials, many of which had not received close attention before the needs of nuclear plant required their employment. The *Materials* volume of the *Reactor Handbook* gathers together a great deal of data on many of the solid materials of special interest to the nuclear engineer, and may be viewed as an extension of such standard works as the A.S.M. *Metals Handbook* into those aspects of the materials which are of special relevance to the nuclear projects The compilation of data in this volume is perhaps the most systematic of the three handbook volumes taken as a whole, as might be expected on account of its more specialist nature Much of the information is new, having been drawn from hitherto classified sources, and is presented in a uniform manner for each material, commencing with accounts of abundance and availability, passing on through extraction and purification, physical and chemical properties, forming and fabrication, including heat treatment, welding and jointing methods, followed by notes on corrosion behaviour and protective techniques and ending with metallography and constitution diagrams. Very little information is given on the effects of irradiation upon the performance of the materials or on the important effects of radiation upon their corrosion-resistance properties, presumably

due in part to pre-Geneva declassification rules, in part to the fact that no data later than August, 1952, is included in this volume and also that the materials testing reactors designed for the investigation of these effects have only comparatively recently begun to yield results, especially in the case of metals, which suffer much less from radiation effects than the non-metals, and consequently require high radiation doses and dose-rates before significant effects become noticeable However, some isolated results of irradiation effects are quoted in the *Engineering* volume in connection with particular coolants.

The *Materials* volume opens with a short account of the general functions of reactor materials, and each chapter contains a short note on the reactor applications of the particular material under review, but in the main this volume is " non-nuclear," and may well be of value in fields quite apart from nuclear energy. It is certainly presented in a form which requires no specialised nuclear energy background for its use and application.

Last, but by no means least, must be considered the *Physics* volume of the *Reactor Handbook* and *Neutron Cross Sections*. These at the present time are probably mainly of value to the physicist and reactor mathematician, but as increasing numbers of engineers are becoming engaged upon reactor design work with the expansion of the nuclear power industry so these volumes will come to be regarded as engineering literature. Between the two volumes a vast quantity of organised nuclear data is presented, following upon short introductory remarks at the commencement of each section. *Neutron Cross Sections* is mainly concerned with scattering and reaction cross-sections for neutrons, which are tabulated for thermal (2,200 m. per second) neutron energies with considerable detail, and also presented in graphical form over the range of energies appropriate to pile neutrons, mainly as total cross-sections, although the separate cross-sections as a function of energy are given in those cases in which they are available. In addition, tables of neutron resonance parameters and the angular distribution of scattered neutrons for some elements and energies are provided. This volume is a revised edition of the original Brookhaven National Laboratory compilation of neutron cross-section data AECU 2040, prepared for the U.S. Atomic Energy Commission, and containing material up to late 1954, but without the supplement issued at the Geneva Conference (and available from the U.S. Government Printing Office through Her Majesty's Stationery Office) giving additional data on the fissile isotopes made available by all partaking nations during the preparatory stages of the Conference, and co-ordinated by the Brookhaven group. Corresponding to this data on the probabilities of neutron reactions is the table of isotopes which occupies about a quarter of the *Physics* volume and describes the properties of the products of the neutron reactions, as well, of course, as those of the stable isotopes, of those naturally radioactive and of the products of other nuclear reactions. The data includes the radioactive decay schemes which are in most cases clearly described by the conventional energy-mass-charge-change diagram, inserted within the framework of the table.

The nuclear physics section of the *Physics* volume is presented in a useful handbook form, consisting of definitions and descriptions of nuclear phenomena and their interpretation, coupled with much tabular data, and a considerable amount of detail of experimental method of results. Thus, although in the form of abbreviated notes with a minimum of descriptive matter, these chapters go some way towards forming a condensed text-book of the nuclear physics relevant to nuclear reactors although most of the material requires some previous introductory background. The chapters on neutron kinetics, reactor dynamics and reactor statics appear, in the main, suited to the needs of the specialist in reactor mathematics. The methods and results of the neutron diffusion theory as applied to reactors, and now becoming familiar to engineers through the several excellent text-books now available, are all contained in these reactor physics chapters, but presented in abbreviated form as special cases of much wider methods of analysis which cannot but allow little space for explanatory text.

The *Physics* volume concludes with a relatively short section (135 pages) on radiation shielding. This surveys the various aspects of this complicated problem in the systematic fashion appropriate to a handbook: the phenomena encountered in shielding work are identified and explained, and in fact this section provides a good summary of the interactions of radiations with matter over the ranges of interest in nuclear reactor shielding problems. However, the problems of combining the separate effects to design an actual shield are very complicated, with the result that it is necessary to resort to experimental methods to solve practical problems. An important tool for such experiments is the BSR or LIDO type reactor, which provides an intense source of mixed radiations suited to the study of reactor shielding, over an area sufficiently large to ensure that the portion of shield under test is not too thick by comparison with its cross-sectional area. Very few results of tests of this type are given in the *Handbook* however, presumably again because of the combination of compilation date and declassification rules. A reference is provided to a literature guide on shielding up to October, 1954.

In summing up, it can be said that these volumes go some way towards filling the large gulf which would otherwise exist between the several excellent introductory text-books now available such as those by Glasstone and Edlund and others on the one hand, and of the material released at Geneva and that now appearing in increasing volume in the technical Press, on the other. The fact that the standards and methods of presentation vary throughout the work is a minor matter; the important thing is that those responsible for producing them have had the courage to produce the material now while it is still useful, rather than awaiting the perfection of editorial presentation and availability, in a form suitable for handbook publication, of more recent additional material.

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NEW BOOKS

***Some of the books noticed here are selected for extended review in* ENGINEERING.**

An Introduction to the Theory of Structures. By W. MERCHANT and A. BOLTON. *Blackie and Son, Limited, 17 Stanhope-street, Glasgow, C.4.*

This new book, on the theory of structures, has been designed for undergraduates during the first two years leading to an honours degree and is based on the lectures currently being given in the Department of Building and Structural Engineering of the Manchester College of Technology. It is intended that the book shall be both sound and simple yet suitable as a foundation for the more advanced and varied techniques now used by structural engineers.

A.S.E.E. Year Book and Technical Guide, 1955-56. *Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1.* (9*d.* to non-members.)

The latest edition of this year book contains an enlarged technical section, in which the principal regulations covering electricity supply and electrical installations are set out. Other subjects dealt with are lightning protection, motors, high-rupturing-capacity fuses, transformers, V-belt transmission and lamps. The organisation and work of the Association are fully dealt with in another section.

Electricity, Magnetism, and Atomic Physics: Vol. I, Electricity and Magnetism. By J. H. FEWKES and JOHN YARWOOD. *University Tutorial Press, Limited, Clifton House, Euston-road, London, N.W.1.* (36*s.*)

This book covers the requirements in electricity and magnetism for the general degrees of the various universities, for the graduateship examination of the Institute of Physics, for Part I of the London special degree in physics, and for Part I of the Natural Science Tripos, Cambridge. Certain aspects of Part II special degree work of London and of Part II of the Natural Science Tripos are also included. Full details of both the theoretical and experimental aspects of the subject are given, special features being the discussion of electrical units and the chapters on the principles of electronics and radio communication.

Creep and Fracture of Metals at High Temperatures. Proceedings of a Symposium held at the National Physical Laboratory, May 31 to June 2, 1954. *H.M. Stationery Office, Kingsway, London, W.C.2.* (30*s.*)

This three-day symposium, held at the National Physical Laboratory in the summer of 1954, was attended by many leading scientists from 15 countries, including Australia, France, Germany, Great Britain, Japan, the United States and Soviet Russia. The 22 papers presented, and the summarised discussions upon them, are contained in the present volume. They are presented in four sections, covering, respectively, deformation processes in simple materials, the creep resistance of complex materials, the theory of fracture, and work on tertiary creep and fracture.

Steel Foundry Dust Control and Ventilation. Report of a Conference held at York, October 13 and 14, 1955. *British Steel Castings Research Association, Broomgrove Lodge, Sheffield, 10.* (42*s.*)

The addresses and papers presented before the York conference, and the discussions to which they gave rise, are given in this publication. The subjects dealt with include dust control on stand grinding machines, swing-frame grinding machines, pneumatic chisels, fettling shops, and at foundry knock-outs; the sampling and assessment of airborne dust and the efficiency of dust collectors; and foundry ventilation and heating. Many half-tone and line illustrations of machinery and plant are included.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Mechanical Forging Press. B. & S. MASSEY, LTD., Openshaw, Manchester, 11. Two types of forging press: high speed, in sizes from 300 to 3,000 tons, and low speed, from 300 to 1,000 tons. The range covers the production of forgings, particularly those of shallow section, which require a minimum dwell period, and those which involve extrusion and require a slower rate of operation to prevent undue abrasive action on the dies. Illustrated brochure.

Seamless Flexible Metal Hose. POWER AUXILIARIES LTD., Kenibrey-street, Swindon, Wiltshire. Technical data concerning the construction and assembly of Plessiflex seamless flexible metal hose for the conveyance of liquids or gases at high pressures between junctions which may expand, vibrate, move angularly, or be exposed to high temperatures. Illustrated booklet, publication No. 808.

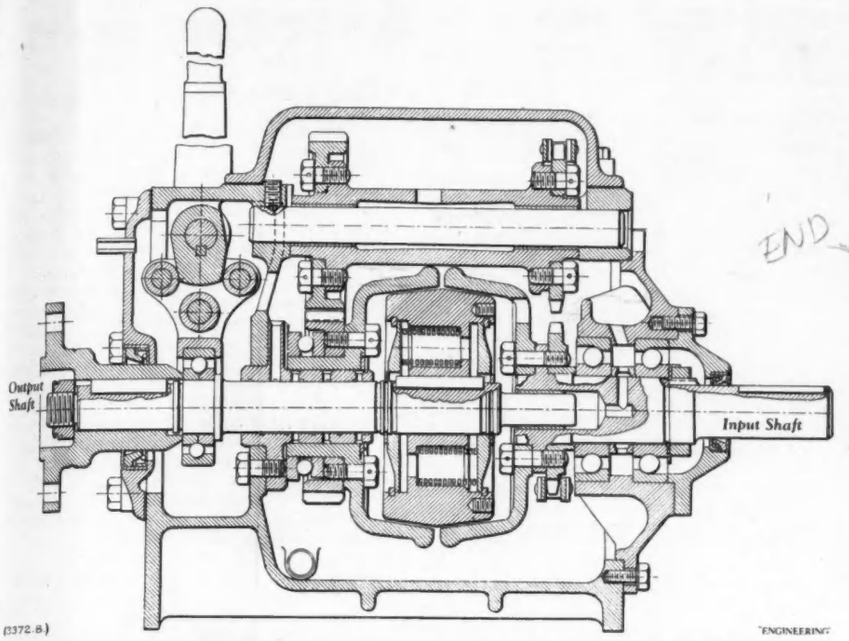
Mining, Portable Tool, Lighting and Neon Transformers. FOSTER TRANSFORMERS LTD., South Wimbledon, London, S.W.19. Technical details of mining, portable tool, lighting and neon transformers. Also of ignition transformers, ring-type current transformers and technical college transformers. Illustrated leaflets and price lists.

Direct Reading Magnetometer. NEWPORT INSTRUMENTS (SCIENTIFIC AND MOBILE) LTD., Newport Pagnell, Buckinghamshire. Magnetometer designed to measure fields from 0·1 to 500 oërsteds with one probe, for use in the transformer, radio and television fields. Full details in illustrated leaflet.

Motors for Machine Tools. LANCASHIRE DYNAMO AND CRYPTO LTD., St. Stephens House, Victoria-embankment, London, S.W.1. Typical illustrations of the wide range of machine tools operated and controlled by L.D.C. motors. Also of special-mounting motors for machine tools. Leaflet.

Photo-Extraction Sedimentometer. EVANS ELECTRO-SELENIUM, LTD., Harlow, Essex. Photo-extraction sedimentometer, which enables particles in the sub-sieve range to be accurately sized. Illustrated leaflet.

Wet-Contact Plants. HUNTINGTON, HEBERLEIN & CO. LTD., Simon House, 28-29 Dover-street, London, W.1. Description of wet-contact process plants, or the production of sulphuric acid from hydrogen sulphide. Illustrated leaflet.



Sectional drawing of the Parsons type A reverse gearbox. The two outer cones of the clutch revolve in opposite directions to give ahead or astern drives.

REVERSE-REDUCTION GEARBOX

TOTALLY ENCLOSED UNIT FOR SMALL MARINE ENGINES

A simple reversing gear designed for application to the smaller sizes of marine engine (up to about 14 h.p.) has been introduced by the Parsons Engineering Company, Limited, Town Quay Works, Southampton. A 2 to 1 reduction gear can be incorporated if desired, and may be seen in the illustration, which shows the gearbox, known as the type A, coupled directly to a "Goosander" engine of Parsons make. The box will transmit ¾ h.p. per 100 r.p.m. up to a maximum speed of 1,800 r.p.m.

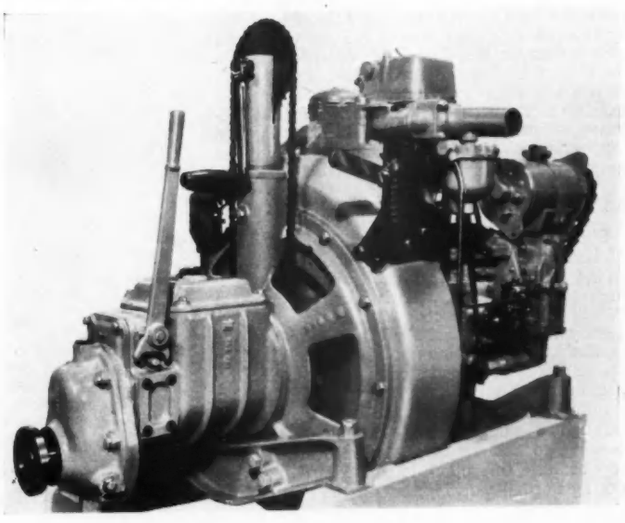
Basically, the drive is obtained by engaging one of two cone clutches which revolve in opposite directions. The one that gives the "ahead" drive is carried directly on the input shaft of the gearbox which also carries a sprocket for driving a layshaft. The cone giving the "astern" drive is driven from the layshaft through a pair of gears and therefore revolves in the opposite direction to the input shaft. The driven member of the clutch has the form of a double cone and is moved to give internal engagement with the driving cones by a hand lever as can be seen in the sectional drawing.

The driven cone is keyed to the output shaft, but has some freedom for axial movement. Springs fitted in recesses maintain pressure between the output shaft and the driving cones by plates which bear against shoulder rings on the shaft. This arrangement permits the output shaft to move a greater distance than is required to engage the cones initially, and will also accommodate a certain amount of wear. The output shaft is carried in a phosphor bronze bearing at the after end, and in a bush in the input shaft at the forward end. When "ahead" gear is engaged, the propeller thrust is transmitted directly to the thrust races that also carry the input shaft (assuming no reduction gear is fitted). Thus in the ahead position, in which by far the greater part of the running is done, there is virtually a straight-through drive, eliminating any chatter in the gear, even when the engine used has a tendency to high cyclic variations at low speeds. When the "astern" gear is engaged, the propeller thrust is taken by a thrust race between the astern cone and a shoulder on the aft phosphor bronze bearing.

The layshaft drive, which gives the reverse rotation for going astern, is made up of a sleeve rotating on a fixed shaft. At the forward end there is a sprocket, driven by a chain from the sprocket carried on the input shaft, and at the aft end a gear wheel which meshes with another attached to the "astern" cone. This cone rotates on the outside of the same phosphor-bronze bearing that carries the output shaft.

The operating lever carries a cam on the pivot shaft which bears against one of two rollers mounted on a forked lever. The other end of the forked lever carries a yoke centering on the outer race of a ball bearing the inner race of which is of split-ring type and mounted on the output shaft. Thus movement of the operating lever in one direction slides the output shaft in the same direction and engages one of the clutch cones. As the operating lever is moved further, one of the rollers on the forked lever rides on to the flat nose of the cam and so provides a non-reversible mechanism which locks the clutch in engagement. A spring-loaded ball holds the operating lever in the central, neutral, position.

The whole of the operating gear is totally enclosed and is splash lubricated. Unit assembly is employed, so that complete items can be replaced if required: for instance, the whole of the forward shaft complete with cone, sprocket and bearings can be replaced with a factory-assembled set if necessary. All bearings are also replaceable. In addition, the lid can be replaced by a different cover which would allow a gear drive to be taken from the lay-shaft to a water pump, generator, bilge pump or other equipment as desired. When a reduction gear is required, a standard unit of 2 to 1 ratio is fitted by removing the propeller shaft coupling, nut, and end cover, when the pinion of the reduction gear will fit directly on the shaft and the casing of the unit bolt directly to the reverse gear casing. Both pinion and wheel are mounted on ball bearings, and thrust races are incorporated to take the propeller thrust. This reduction is also spash lubricated.



A 2 to 1 reduction gearbox can be fitted directly to the reversing gear as shown here. The unit is mounted on a Goosander engine.

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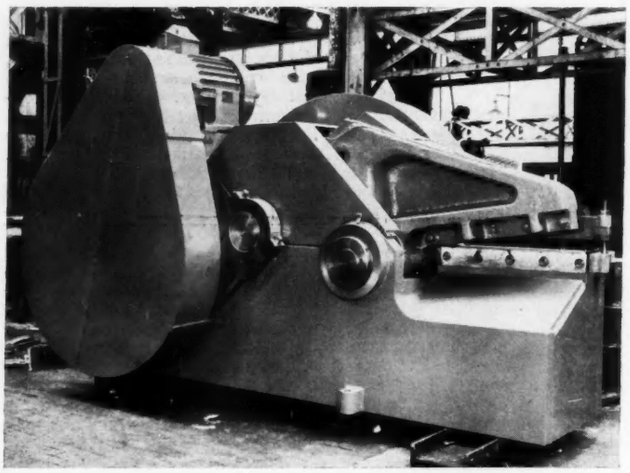
HIGH OUTPUT TUNNEL KILN FOR REFRACTORY BRICKS

A new Tunnel Kiln, to be known as the "Kirkby Kiln," was recently put into operation at the Worksop Plant of General Refractories Limited, for burning of basic refractories. The kiln is capable of firing at temperatures up to 1,650 deg. C. and has a total overall length of 346 ft. It will hold 56 cars, each with a capacity of approximately 5 tons, giving a weekly output of 600 tons of fired bricks. The kiln is of the latest design and is fired by 950 seconds fuel oil through a total of 40 Schieldrop P-type burners situated in the kiln side walls.

All the refractories were supplied from various works of the G.R. Group and those in the hot zone are of G.R. Sillmax 63/100, a special grade of Sillimanite brick. The kiln is housed in a long, wide-span steel-framed building in which car loading, unloading and palletisation facilities have been installed to reduce the handling of the refractories to a minimum. The whole project was completed to an overall scheme by General Refractories, who placed the contract for the design and construction of the tunnel kiln with British Ceramic Service Company, Limited, of Glasgow.



Cutting of steel scrap ready for re-melting is the function of this Bigwood shear, which is designed for operation under arduous conditions in the open air.

CUTTING UP SCRAP FOR THE FURNACE

MODERN VERSION OF AN OLD TYPE OF MACHINE

The crocodile or alligator shear is the oldest of all the metal-cutting machines, having evolved from the simple hand shears or scissors. Many of these shears are in use to-day, though newer designs have largely taken their place in situations where accuracy of cut and quality of the sheared edge are important. There is, however, one application for which the crocodile shear remains ideal. This is the cutting up of steel scrap ready for re-melting. Accuracy of cut and the condition of the sheared edge are unimportant in this type of work, but the machine must be very robust, able to deal with any kind or section of steel, and capable of giving long, trouble-free service, often in the open air.

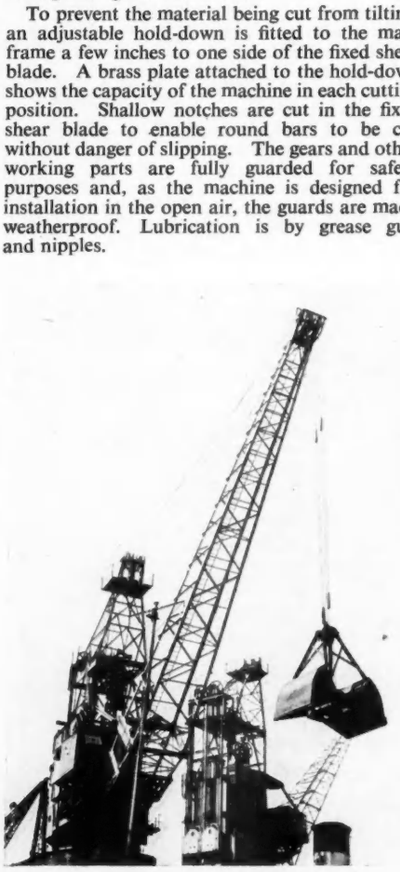
To meet these conditions, and also to eliminate the unsatisfactory features sometimes found in orthodox crocodile shears, Joshua Bigwood and Son, Limited, Wolverhampton, have designed and built the machine illustrated herewith. It has a capacity of 30 in. by $\frac{5}{8}$ in. plate, $2\frac{3}{4}$ in. diameter round bar, and 7 in. by 3 in. rolled steel joist.

The main frame of the shear is of stress-relieved fabricated steel. This frame carries the fixed bottom shear blade. The top blade is carried on the pivoting beam, which is a steel casting of rigid section. A phosphor-bronze bush rotating about a steel shaft mounted in the main frame provides the bearing for the pivoting beam. Wear on the main beam bearings, caused by the side thrusts on the beam during cutting, can be very heavy, and it is often aggravated by weather conditions when the machine is installed in the open air. This machine, therefore, is fitted with a thrust plate with a fine screw adjustment, which is used to take up wear at the thrust faces. Wear adjustment is independent of the blade clearance setting, which is done by shimming in the normal manner.

EASY REPLACEMENT OF SHEAR PIN

Shear pin protection is important in a machine of this type, which can easily be overloaded. In the present design such protection is provided in an unorthodox way. Drive for the top beam is taken from an electric motor through nylon belting to the flywheel shaft and thence to the crankshaft by a pinion and gearwheel. The crankshaft is of forged steel, and drives the top beam through a pitman at a speed of 25 strokes a minute. The pitman small end is connected, through a gudgeon and knuckle-type thrust bearing, to a block in a machined slide in the top beam. This block is pinned to the beam during normal working, but in the event of an overload, the shear pin fractures and allows the block to work idly to and fro in the slide in the beam. Choice of this position for the shear pin was based on the fact that it gives greater protection to the machine, and the pin is more easily replaced than if it were in the gear drive. The general disposition of the shafts is such that heavy reactions on the crankshaft bearings during the cutting stroke are taken on the bearing surfaces opposite to the caps, the latter only taking the light return loads.

To prevent the material being cut from tilting, an adjustable hold-down is fitted to the main frame a few inches to one side of the fixed shear blade. A brass plate attached to the hold-down shows the capacity of the machine in each cutting position. Shallow notches are cut in the fixed shear blade to enable round bars to be cut without danger of slipping. The gears and other working parts are fully guarded for safety purposes and, as the machine is designed for installation in the open air, the guards are made weatherproof. Lubrication is by grease gun and nipples.



100 ft. jib of light-alloy construction.

WATER-SAVING SPRAY NOZZLE

Fine Spray or Jet as required

Ford airies, breweries, garages, and wherever a water hose is normally used, Meynell and Sons, Limited, Montrose-street, Wolverhampton, have introduced the hand-controlled spray nozzle illustrated herewith. It gives the operator full control over the supply of water, the discharge varying from a fine mist to a full-bore jet, according to the pressure applied to the hand-lever. The valve is spring-loaded to close, and the water flow ceases immediately the hand-lever is released. Only the exact amount of water necessary for the job in hand need therefore be used, with a consequent saving in water. A lock-ring enables the valve to be held open if required.

The spray nozzle has a bronze body with a renewable rubber cover, which protects both the nozzle itself and any equipment with which it might come into contact when in use. The working parts are few in number and are designed for easy replacement. To dismantle the nozzle, the rubber cover is first pulled off, and the hand-lever, which is pivoted on a nylon bush, is removed by taking out the pivot screw. The screwed nosepiece is then removed, and the complete working parts can be pushed out in cartridge form. The cartridge, which leaves behind it the rubber valve seat and water-directing cage (both of which are renewable simply by placing in position by hand), consists of a spindle, spring, gland to prevent water from passing back along the spindle, and an adjusting screw. This screw enables the user to set the nozzle to give either a full range of sprays or a single type of spray as required.

The Meynell water spray nozzle enables the user to control the flow from mist to full jet, and closes immediately the hand-lever is released.

The nozzle is designed for use with hot or cold water at any normal pressure (but not steam), and is supplied as standard with two adaptors for use with either $\frac{1}{2}$ in. or $\frac{3}{4}$ in. hose. A fire-brigade and other fittings can also be supplied.

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ALUMINIUM CRANE JIB

Following the successful employment of two aluminium-alloy jibs at the Purfleet Wharf of William Cory and Sons, the company invited Hawksley S.M.D. Limited, Slough, to tender for the design and fabrication of a jib, 100 ft. long, at their Rochester yards. The finished jib is illustrated on the left.

The alloy used is HE 30 WP, which is of medium strength but with good corrosion resistance properties. The jib is of riveted and bolted construction, and has been designed to have a factor of safety of 4 in compression and 4·5 in tension; it has a weight of 4·2 tons, as compared with 10 tons for a steel jib, so reducing the amount of kentledge that has to be carried to assure against overturning.

UNIVERSAL TESTING MACHINE FOR STRUCTURAL COMPONENTS

PROVISION FOR MEASURING LATERAL AS WELL AS VERTICAL LOADS

The 500 ton vertical universal testing machine built by W. and T. Avery, Limited, Soho Foundry, Birmingham, 40, for the Naval Construction Research Establishment, Rosyth, is the largest of its particular type in the country, and it possesses some unique design features. In particular, it is arranged for measuring the lateral components of the forces on the end of a strut as well as the vertical component of the load. The machine will carry out compression, tension or transverse tests, the capacity and specimen size ranges being as given in the accompanying table.

Capacity and Specimen Size Ranges on 500 Ton Vertical Universal Testing Machine

Capacity (4 ranges) ..	500 tons by 1 ton. 250 tons by 0·5 ton. 100 tons by 0·2 ton. 50 tons by 0·1 ton.
Side load dials	0 to 25 tons by 0·1 ton.
Specimen accommodation	Tension, 11 in. minimum, 25 ft. 11 in. maximum between tension shackles. (5 in. diameter pin.) Compression, 0 to 27 ft. Top platen 2 ft. 6 in. diameter spherically seated, or 6 ft. by 4 ft. removable fixed type. Bottom platen 6 ft. by 4 ft. Transverse, 2 ft. to 25 ft. by 3 ft. roller width. Top beam for four-point loading 2 ft. to 25 ft. by 3 ft. roller width. Clearance between columns; front, 8 ft., side, 4 ft.

The base of the machine is a heavy steel casting, and on this base are mounted four vertical cast iron columns, which are tied together at the top. Machined surfaces on these columns act as guides for the main straining crosshead, which has large contact areas with adjustable slippers. Vertical adjustment of the straining head is by means of four screws, one in each column, which are connected at the bottom to a crosshead which is, in turn, connected to a down-stroking hydraulic ram and cylinder. Two auxiliary cylinders support the weight of the moving parts; they also serve to return the main ram, and act as recoil absorbers when a specimen breaks. The main hydraulic ram and cylinder apply the straining load, the vertical screws being used solely for adjustment of the working height of the straining head.

SIDE LOAD MEASUREMENT

The lower compression platen and bending beam are in the form of a table for measuring the load. The beam is supported on two bridge castings and four compression flexures; these connect with two tension flexures attached to the load platform. By this means of suspension lateral movement is possible in any direction, loads being indicated on two dials, one each side of the main load dial, on the control cabinet. Each dial is graduated up to 25 tons on either side of a central zero; the left-hand dial indicates the side load to the left or right, while the right-hand one shows the load forwards or backwards.

The whole of the laterally-flexible assembly is carried on a weighing table resting on four main levers which are in turn connected by transfer levers to the main pendulum resistant mechanism for indicating the magnitude of the vertical load. A variable-ratio lever is used to give four ranges of capacity, the major figures on the dial being changed appropriately by the internal mechanism when the capacity-change handwheel is operated.

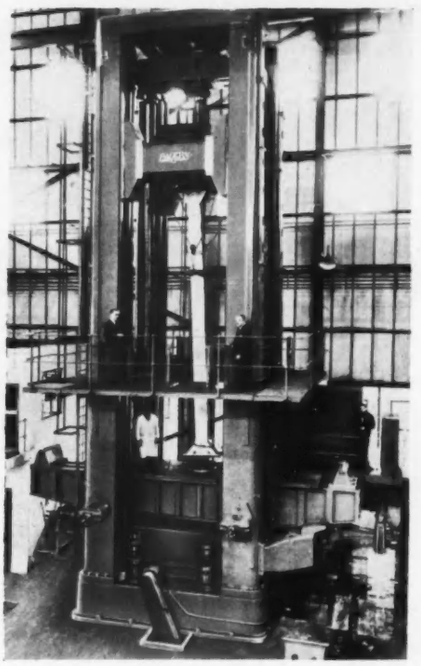
TENSION TESTING

Four vertical round steel struts, guided in the vertical cast iron columns by flexure stays, are carried on the weighing table, and the top crosshead which carries the tension shackle is fixed to the struts at the point required by hand-operated clamping jaws which engage with grooves at intervals on the struts. The tension crosshead is raised or lowered by means of the compression crosshead, which is provided with removable props for this purpose.

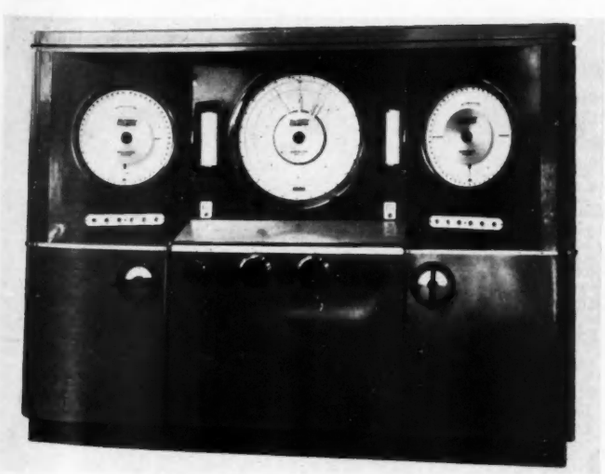
Access to the test piece is obtained from an operator's platform guided on the outside of the four main columns. It is supported when stationary by four spring-loaded pawls; a handwheel control on the cabinet enables them to be withdrawn for downwards movement. For upward movement the pawls are not disengaged. Movement of the platform is by motor, gearing and wire rope, under control from push-buttons on the instrument cabinet.

Four push-button stations are provided on one of the vertical columns for adjustment of the straining crosshead. These enable the crosshead to be set accurately when a test piece is inserted. All the other controls are grouped with the three load-indicating dials on the control cabinet. Push-buttons are provided for controlling the main pump, auxiliary pump and hoist, and tumbler switches control autographic recorders for load/travel and load/time. A ram stroke indicator is similarly controlled. Hydraulic valves control the rate of loading and release of load, and a further valve is provided for raising the main ram. A mechanical load-relief handwheel enables the load to be maintained on the test piece, but relieved from the weight-indicating mechanism so that the capacity range can be changed during a test. Indicator lights show which motors are running.

Provision is made for load holding by means of electric contacts on the dial which control the straining mechanism through solenoid valves, and for load cycling, by two auxiliary pointers set to the maximum and minimum load required. The load will automatically oscillate between these set limits, the rate being controllable by the setting of the admission and release valves. A disc concentric with the dial can be rotated by a constant-speed motor at from 1 to 50 divisions per minute, and the load pointer can then be set to move at the same speed, so obtaining a constant rate of loading.



Rear view of machine, with specimen in position.



Control cabinet. The centre dial indicates the vertical load and the two side dials show the lateral loads.

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B.E.A. CONTRACTS

Contracts have now been signed by British European Airways for 20 Vanguard, 14 Viscount 806 and two Viscount 802 air liners to be delivered by Vickers-Armstrongs, Limited, in addition to the 24 Viscount 802 aircraft already on order. The Viscount 802 has now made its maiden flight; the first Viscount 806 is due for delivery next summer.

The first Vanguard, to be powered by the Rolls-Royce Tyne propeller turbine, is expected to fly in the autumn of 1958 and should be delivered to British European Airways in 1960. This versatile aircraft, with a cruising speed of 400–425 m.p.h., is designed to carry the full payload of 21,000 lb. over sector distances up to 2,600 miles. With a double-bubble fuselage, it can carry the entire payload in the form of passengers, freight, or a combination of both.

On the day following the signing of these contracts with Vickers-Armstrongs, Limited, B.E.A. took delivery of their first twin-engine 12–14 seat 173 helicopter (one of the two prototypes) from Bristol Aircraft Limited. It will be carrying out a programme of extensive handling trials, based at Gatwick airport. The Bristol 173 helicopter, powered by two 520 h.p. Alvis Leonides engines, is the fore-runner of larger twin-engine helicopters projected by Bristol for commercial use. Three more Bristol 173 prototypes are to be built with 850 h.p. Leonides Major engines, and design studies have been completed for a 20 passenger gas-turbine-powered helicopter to cruise at 140 m.p.h. over sector distances of more than 100 miles.

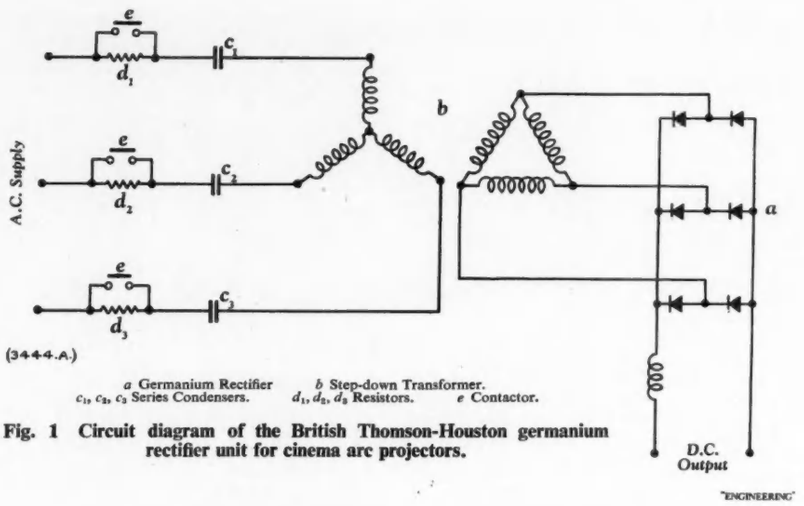

Fig. 1 Circuit diagram of the British Thomson-Houston germanium rectifier unit for cinema arc projectors.

GERMANIUM RECTIFIER FOR CINEMA WORK

The British Thomson-Houston Company, Limited, Rugby, has designed a germanium rectifier to meet the higher power requirements of the arcs used in modern cinema projectors. This rectifier has an efficiency of 91 per cent., so that it has been possible to reduce the size of the unit without overheating. By incorporating capacitors in the primary circuit of the transformer to stabilise the arc it has also been possible to obtain a leading power factor and thus to cancel the lagging power factor produced by the other equipment.

A simplified diagram of the unit is given in Fig. 1 in which the full wave germanium rectifier itself is shown at *a* and the double wound step-down transformer, from which three-phase power is obtained and which ensures that the direct-current output is isolated from the mains, at *b*. The series condensers, which are connected in the primary circuit of the transformer to stabilise the arc and give a leading power factor, are indicated at c_1, c_2 and c_3. The impedance of these condensers also prevents heavy currents flowing through the rectifier when the arc is on short-circuit. Tests have shown that when the rectifier is connected to give 110 amperes at 56 volts the short-circuit current is limited to 150 amperes. No power is lost in the condensers as would be the case with a ballast resistor. Fig. 2 shows the voltage and current regulation with the series condensers set to a particular value.

As will be seen from Fig. 1, the rectifier is made up of six elements which enables the direct-current ripple voltage to be kept down to a minimum, and at the same time increases the ripple frequency to 300 cycles, thereby facilitating smoothing. When the rectifier is used with a projector equipped for the reproduction of sound, an external choke is supplied to reduce the ripple voltage to 0·6 volts root-mean-square, a figure which it is found keeps the hum to an acceptable level. As will also be seen from Fig. 1, three resistors—d_1, d_2 and d_3, are connected in series with the stabilising condensers to prevent surges when switching on. They are short-circuited by the contactor *e* soon after the arc is struck.

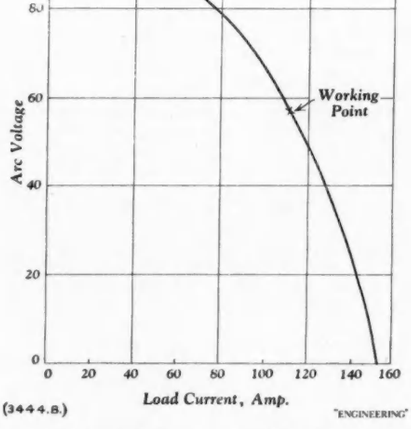

Fig. 2 Regulation of arc voltage and current.

Fig. 3 Cubicle of germanium arc rectifier with covers removed.

The new rectifier is illustrated in Fig. 3 with the covers of the ventilated cubicle in which it is housed removed. This equipment is designed to supply one arc, and to give a continuous direct-current output of 110 amperes at 56 volts. When used on a duty cycle of 20 minute-on-20-minute-off this rating may, however, be increased, the amount of the increase depending on the supply voltage. The minimum output is 75 amperes at 48 volts. Current adjustment is effected by tapped connections on the stabilising condensers and, in addition, a "low-normal-high" switch can be supplied to give a ± 5 ampere variation in the direct-current output while the rectifier is on load. Alternatively, the output may be stepped up by any fixed amount within the rating of the carbons by a remotely controlled contactor.

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MOLTEN-METAL PYROMETER

A new thermocouple for use in determining in the crucible the temperatures of molten non-ferrous metals and also cast iron, has been put on the market by the Cambridge Instrument Company, Limited, 13 Grosvenor-place, London, S.W.1.

As will be seen from the accompanying illustration, the thermocouple consists of a removable closed-end sheath made of graphite mounted at the end of a mild-steel tube, about 30 in. long, terminating in a junction box. The tube is fitted with a circular shield to protect the junction box from the heat radiated from the hot metal, thus safeguarding the cold junction of the thermocouple from severe fluctuations in temperature.

Thermocouple pyrometer for measuring temperature of molten metal in a crucible.

For use with non-ferrous metals at temperatures not exceeding 1,100 deg. C., the thermocouple elements are of base metal (Chromel-Alumel), approximately 36 in. long. They are inserted through the tube and connected to terminals in the junction box so that, when necessary, replacements can be made readily.

For higher temperatures, up to 1,550 deg. C., the thermocouple elements are of rare metals (platinum-platinum-rhodium). The general arrangement of the thermocouple is similar to the type just described but the mild-steel tube is replaced by one of nickel-chromium and the element wires are about 4 ft. long, the surplus wire being wound on small reels contained in the junction box. When, as a result of use, the tip of the thermo-couple deteriorates, it is cut off and the wire renewed by unreeling a short length and remaking the junction by twisting the wires together.

The average lag of both types of thermocouple is about 25 to 28 seconds when the graphite sheath is new, but as the sheath becomes thinner with use the lag decreases to from 18 to 20 seconds.

Asbestos-covered compensating leads connect the thermocouple to the temperature indicator or recorder. The leads are brought from the junction box through a heavy steel conduit tube, which is bent at a convenient angle.

The Machine Tool Industry (*continued from page* 156)

In introducing this series, we referred to speed, accuracy and consistency as the qualities a potential machine tool buyer is likely to seek. To achieve and maintain the last two, measuring instruments, which provide the subject of the first article this week, are of prime importance. Automatic operation and flow-line production have also been recurrent themes in the series, and both automatic checking devices and electrical control equipment, which is treated in the second article, have contributed to these developments. Previous articles have dealt with: automatic control systems, machining light alloys, spark erosion, welding equipment, drilling, boring and milling, turning, screwing and threading, cutting fluids and slideway lubricants, furnaces and heaters, woodworking machinery, sawing, grinding and surface finishing, marking and engraving, broaching, forging and stamping, and sheet and strip metal working.

INSTRUMENTS

At every stage in machining there needs to be some form of inspection of the finished part to make sure that tolerances are being maintained. It was therefore natural that at the Machine Tool Exhibition many measuring instruments should be shown. Possibly the greatest increase during recent years has been in the field of the comparator which, once it has been set to the required size, immediately indicates any deviation in the part. This development follows from the increase in repetitive work. The tendency to build up special gauges from several standard heads fitted together to form some sort of measuring jig was also well illustrated; all these developments had the object of speeding up the process of inspection.

BUILT-UP JIGS

British Indicators, Limited, Sutton-road, St. Albans, Hertfordshire, were showing examples of the built-up gauge using several dial gauges arranged on a jig. One such is shown in Fig. 1. This particular arrangement is designed for checking the complete envelope of a turbine blade at 16 points simultaneously, and comprises a base upon which the blade is mounted, together with two bridges carrying the indicators disposed for checking the required points. The indicator carriers are adjustable and therefore can be arranged for any length of blade, or to check larger blades at any desired point. The instrument is set from a master. A comparator for the fir-tree serrations in gas-turbine rotors was also displayed by this company, who are the makers of the " John Bull " range.

A range of dial gauges, particularly intended for measuring small bores, was displayed by J. E. Baty and Company, Limited, 39 Victoria-street, London, S.W.1, for the range of sizes from $\frac{1}{16}$ in. up to $\frac{1}{2}$ in. in diameter. They have diametrically opposed measuring contacts and a centralising shoe, enabling them to check diameter, out-of-roundness and taper of the bore to fine limits. The largest bore for which this company makes a gauge is 36 in.

The extensometer made and exhibited by Thomas Mercer Limited, Eywood-road, St. Albans, Hertfordshire, also includes a dial gauge for showing the movement: it is illustrated in Fig. 2. The gauge length is 2 in. and the capacity of the smaller size is up to 0·625 in. in diameter or thickness, and of the larger size, up to $1\frac{1}{2}$ in. in diameter. The magnification factor is 1,250 to 1 and the gauge will clearly indicate alterations in length of the specimen of the order of 0·00001 in.; these are particularly suitable for proof stress determinations.

COMPARATORS

The wide range of comparators made by the Sigma Instrument Company, Limited, Letchworth, was displayed by Alfred Herbert and Company, Limited, Coventry. Those that are mechanical in operation have magnifications ranging from 300 to 5,000, with capacities from 6 in. to 24 in.

For the inspection of ball races and bores, Taylor, Taylor and Hobson, Limited, Stoughton-street, Leicester, were showing their Talymin bore comparator. Two sizes are available, one covering the range from $\frac{1}{2}$ in. to $1\frac{1}{2}$ in. nominal diameter, and the other from $1\frac{1}{2}$ in. to 4 in.; the magnification is 1,800. The Talymin gauge head can also be used in conjunction with a recorder for small displacements that are associated with the testing of parts and the analysis of machine errors. Heads are available which can be used either axially or at right angles to the axis. Magnifications on the recorder chart can be from 100 to 5,000.

AIR GAUGES

The use of air for gauging is another development that has occurred comparatively recently and an example is that of the multi-dimensional semi-automatic gauge for checking cylinder liners displayed by Solex Gauges Limited, 72 High-road, Chiswick, London, W.4, and illustrated in Fig. 3. Six measurements are made simultaneously, three positions of the inside bore and three positions of the outside diameter; all readings are shown on an illuminated panel, and pedal operation is fitted.

Fig. 3 Pneumatic comparator for cylinder liners. (Solex Gauges Ltd.)

Wickmans Limited, Tile Hill, Coventry, were also showing a range of air comparator units on which the dimensions to be measured are read directly. These employ plug or ring feeler type gauge elements. The capacity range is from 0·12 in. up to 4 in. and four measuring ranges are available between 0·0005 in. and 0·003 in.

THICKNESS AND SURFACE FINISHES

A gauge for the continuous measurement of the thickness of strip from cold-rolling mills was exhibited by Taylor, Taylor and Hobson Limited; it consists of two rollers which are pre-set to the nominal thickness of the strip, and between which the strip passes as it emerges from the mill. Any variation in the thickness down to the limits of 0·0001 in. are immediately recorded on a centre zero meter; adjustment to the gauge setting can be made without slowing down the mill. The maximum opening of the gauging rollers is $\frac{1}{8}$ in. and the throat depth 5 in. Power is supplied from the 50 cycle mains, and normal supply variations do not affect the reading of the meter. Range lengths on the gauge scales that are available are 0·002 in., 0·005 in., 0·01 in. or similar values in millimetres.

There were many instruments displayed for the

Fig. 1 Jig for checking turbine blades. (British Indicators Ltd.)

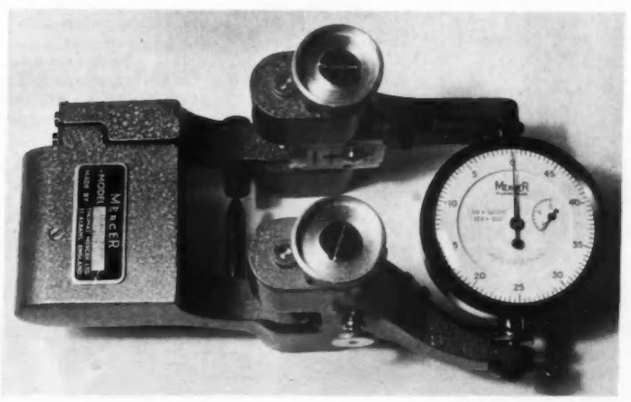

Fig. 2 Extensometer for 2 in. gauge length. (Thomas Mercer Ltd.)

measurement of surface roughness, including the Talysurf range of Taylor, Taylor and Hobson, Limited. Three models of this are now available giving vertical magnifications up to 50,000 times.

Other methods were shown by Hilger and Watts, Limited, 48 Addington-square, London, S.E.5, involving interferometry. These work on the principle of the interference fringes that are formed when the workpiece is compared with an optically-polished front-surface mirror. Since the fringes are most distinct if the comparison surface has a reflecting power equal to that of the sample, the mirror in this instrument has three sections with reflectivities of approximately 4 per cent., 50 per cent., and 90 per cent.; these are interchangeable by turning a knob. Variations from a perfect surface from anything between one micro-inch and 40 micro-inches can be observed directly using mono-chromatic light, and greater degrees of roughness when using white light. The operation of the instrument is simple and it can safely be used by an unskilled operator after short instruction.

LENGTHS, DIAMETERS AND ANGLES

Flat surfaces such as slip gauges and convex surfaces such as ball-bearings and cylinders may be examined directly, but concave surfaces are not usually accessible and examination can be made through the intermediary of a plastic film replica.

For the exact measurements of length or diameter the Société Genevoise d'Instruments de Physique, of Geneva, were showing several models varying both in size and in accuracy according to the requirements; the guaranteed measuring accuracy of one instrument, for example, was to 0·000028 in. The newest of these is the F-IA, which has a large table surface of 400 mm. by 750 mm., which will take workpieces up to 750 mm. diameter and with a maximum weight of 200 kg. The table is mounted on rollers which run in a V at the front of the machine and on a flat way at the rear; the longitudinal displacement is measured by a SIP standard scale fixed to the bed of the machine and viewed by an objective fixed to the table. The image is thrown into the second objective which is fixed to the bed. A similar scale is mounted on the vertical column, but in this case there is only one objective in the microscope and a magnification of five times is used. A vertical line running along the scale when compared with two small lines on the retical of the ocular micrometer gives a check of the verticality of the arrangement. Many accessories are available, including a transverse table and a short focus microscope which enable measurements to be made in three directions, as well as such items as a goniometric microscope, dividing tables and inclined tables.

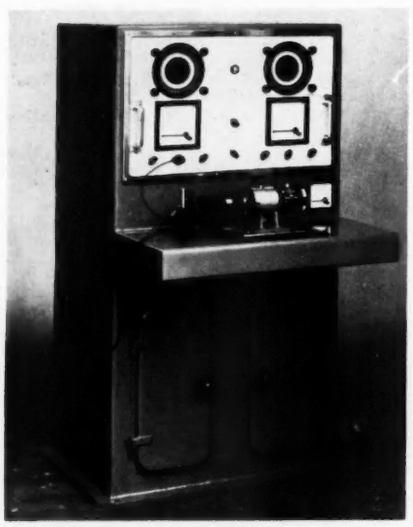

Fig. 5 Dynamic balancing machine for small components. (Sidney G. Jones Ltd.)

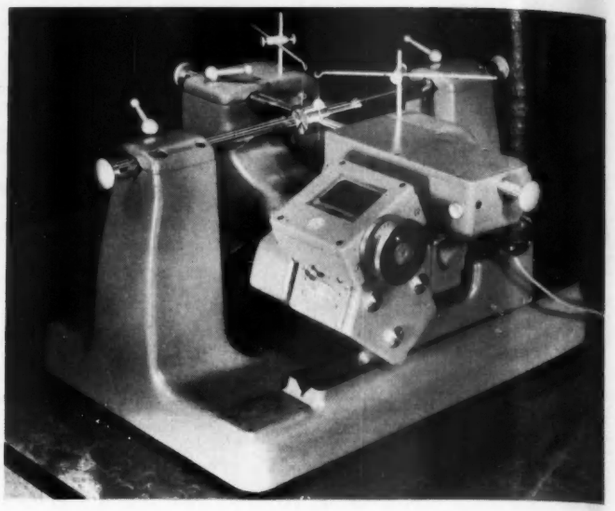

Fig. 4 "Matrix" instrument for measuring diameters. Of floating carriage design, it will accept work up to 4 in. in diameter and with the aid of an optical unit gives readings over a 1 in. range directly to 0·0001 in. without resetting. (Coventry Gauge and Tool Co. Ltd.)

MAGNIFIED PROJECTION

Another method of inspection of a finished workpiece is by projecting an enlarged image of it upon a screen, and here again several firms were showing instruments for this purpose. Among these firms were Hilger and Watts, Limited, 98 St. Pancras-way, London, N.W.1, who were showing several models. One of these was a free-standing machine having a work stage 15 in. in length and a horizontal face 3½ in. wide with a vertical face of 2¾ in. deep. Both faces are fitted with T-slots for clamping the work. The fixing brackets supplied will accommodate a maximum work length of 9 in. and a maximum diameter of 8 in. The stage will carry weights up to 30 lb. It is also possible to tilt the stage to ±2½ deg. to enable work to be lined up in the direction of traverse. The whole worktable assembly can be rotated in either direction about a vertical axis through an angle of about 30 deg. so that hobs and other acute helix work can be projected. The focusing adjustment range is approximately 3 in.; correct magnification is assured by keeping the distance of the projection screen from the objective rigidly fixed. The focusing movement is comparable in accuracy with the measuring movement, and consequently points on the object which lie in different planes can be accurately measured although they must be focused separately. Models can be fitted with either micrometers or accurate glass scales in their place; the latter have the advantage that direct measurements may be made over the whole horizontal distance of 6 in. and the vertical distance of 2 in. without having recourse to the use of slip gauges. A single eyepiece is used to read both scales, the changeover being effected by a switch. The projection screen is 17 in. in diameter and is provided with cross lines; it has a grey surface chosen to give a clear bright image. It is mounted on a rotatable circular metal frame engraved with a protractor scale the divisions of which can be subdivided to one minute of angle by means of a slow motion driven by an engraved operating drum.

Another projector shown by the same firm is the Chekker, which can be used in a horizontal or a vertical position and has an overall height of 33 in. It is designed for the workshop and the general inspection department. When horizontal the instrument is set up on a bench and requires 20 in. by 33 in. of bench space. Bright, clear images are thrown on a screen covering 10 in. by 8 in. and no curtains are needed. Three magnifications are obtainable by interchange lenses and these are 10, 25 and 50. The work platform has bevelled sides and the plane surface is 3·6 in. by 5·5 in. It is mounted on a pillar that can be raised or lowered and also rotated about its axis.

The measuring of screw threads requires a technique largely its own, and among the firms displaying this type of equipment was the Coventry Gauge and Tool Company, Limited, P.O. Box 39, Fletchamstead-highway, Coventry. An instrument which will accept work up to 4 in. diameter is the one shown in Fig. 4. This is basically of the floating carriage type originally designed by the National Physical Laboratory, and developed in conjunction with Hilger and Watts Limited; it incorporates a high precision optical unit enabling readings to be taken over a 1 in. range directly to 0·0001 in. without the necessity of resetting the machine. Measurements both along the centre line and at right angles to the component are possible. The optical unit contains a glass scale graduated in 0·01 in. divisions which are projected at a high magnification on to a ground-glass screen. At the side of the screen is a micrometer which subdivides the readings into 0·0001 in. divisions; a zero setting feature facilitates setting up. In order to cover the complete measuring range only two reference setting discs, one of 1 in. and one of 3 in. in diameter are required. The optical unit, being a sliding mechanism, enables repetition checking of work of similar dimensions to be carried out rapidly and accurately. Radial measurements can also be made by locking the carriage and bringing the moveable anvil into contact with the work. The machine has a work capacity between centres of 9 in.

Another instrument exhibited by this firm was for plain pitch measuring. It will detect pitch inaccuracies of less than 0·0001 in. over a range of 2 in. on all forms of thread, and will repeat the readings to 0·00002 in.

BALANCING

Machines which may well be classed under the heading of instruments are those designed for the balancing of rotating components. Two models of static balancing machines were displayed by Benrath Machine Tools, Limited, Longley-lane, Wythenshawe, Manchester. The SV model has a horizontal work table which is suitable for such items as flywheels, impellers or pulleys which have a central hole and for which only a static balance is required. At one side of the table is mounted an unbalance indicator consisting of a spirit level with a ground vial which enables a fine balance to be obtained. In operation, the part to be balanced is rotated on the table until the indicator shows a maximum after which a sliding weight is moved along a graduated steel yard to restore the balance level to zero. Mounted above the table is a drilling head which is used to drill out the required quantity of metal. The reading on the sliding weight can be converted by means of a chart to the size and depth of hole to be drilled. Three sizes of machine are made having

capacities from 10 in. in diameter to 26 in. in diameter and weighing up to 200 lb.

Another range of balancing machines are those made by Hofmann Machine Tools and exhibited by Sidney G. Jones, Limited, 8 Balham-hill, London, S.W.12. The machines range from a capacity of 11 lb. to 6,600 lb. and will take rotor diameters from 12 in. to 97 in. One of the smaller models is illustrated in Fig. 5. These machines are based on the principle of direct indication, and the electrical frame in the construction allows the setting up of the compensation planes in any desired plane, and compensation from residual moments is practical. The central zero instrument is fitted above or beside the main instrument and allows the measuring in each plane to be made in between 5 and 20 seconds, depending on the size of the machine. The electrical scale of the balancing frame can be multiplied between 2 and 10 times by means of potentiometer multipliers, and the measuring range on the dynamic machines is normally graduated at 1 : 100. Unbalance eccentricity of the axis of rotation can be proved to 0·0002 to 0·002 mm., depending on the size and properties of the rotors.

The Machine Tool Industry

ELECTRICAL CONTROL EQUIPMENT

The underlying theme of our previous articles on the machine tool industry has been the use of automatic techniques, and this has been amply illustrated by the descriptions we have given of representative equipment shown at the Machine Tool Exhibition. The development of such techniques has, however, been mainly due to the assistance of the electrical engineer in providing not only the necessary driving motors, but the subsidiary equipment by which they can be accurately controlled with a minimum of human intervention.

It was therefore not surprising that a number of electrical manufacturing firms took the opportunity of showing what they had done to assist the machine tool industry towards automation by exhibiting examples of their motors, switchgear, relays, automatic control systems and lighting equipment, so to speak "in the raw." A great number of their products were naturally of standard design and had much wider applications than in the machine tool industry, but it showed clearly to the non-electrical visitor the developments which have taken place in a field supplementary to that of machine tools.

AUTOMATIC SETTING ON BORERS

The British Thomson-Houston Company, Limited, Rugby, for instance, had a representative selection of their automatic control systems on a number of stands including an arrangement of automatic co-ordinate setting, intended primarily for boring operations, which was shown both on a Kearns horizontal boring machine and on a Newall jig borer. Both machines are provided with automatic control of two feed motions. The position location can be set by "dialling-in" the required dimension for each feed motion on six simple ten-position controls. These controls are set up to a six digit number corresponding to the dimensions required in tens of inches, inches and four decimal places. Alternatively a punched-card system can be used to set up all twelve controls. The accuracy of location is better than 0·0002 in. on the Kearns machine and than 0·0001 in. on the Newall borer. (See ENGINEERING, June 22, page 537, 1956).

Other equipment exhibited by the same firm included complete electric motors, as well as stator and rotor units for building into tools. A great variety of power and electronic control gear was also shown, a typical example of the latter being the cubicle illustrated in Fig. 1 which has been designed for electronically controlling a 50 h.p. planer table drive.

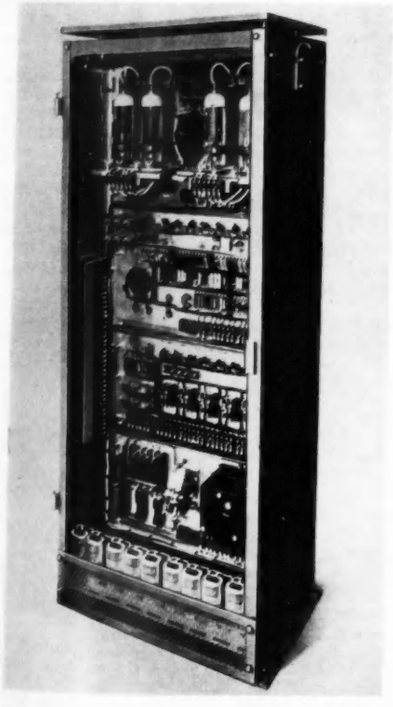

Fig. 1 Electronic equipment for controlling a 50 h.p. planer table drive. (British Thomson-Houston Co. Ltd.)

SPEED CONTROL OF LATHES

Crompton Parkinson, Limited, Aldwych, London, W.C.2, staged a number of demonstrations to show various systems of control and production for machine tool drives. One of these consisted of a lathe driven by a ½ h.p. motor, the speed of which could be controlled by a hand-operated regulator. This regulator varied the armature voltage so that speeds up to 1,500 r.p.m. were obtainable at a constant torque. At higher speeds a field rheostat came into action and provided a constant horse-power output. This combination of constant torque and constant horse-power characteristics has been designed to drive the average machine tool with a variable speed over a wide range in a most economical manner. Similar equipment for horse-powers up to 2 is being developed.

A second demonstration unit featured a variable overload device consisting of a contact-making ammeter which could be set to trip out an electric motor, in this case one with an output of ¼ h.p., if a pre-determined current was exceeded. It can, however, be used on any size of motor by connecting a current transformer in the line.

MOTORS FOR MACHINE TOOLS

The static machine exhibits on this stand included a number of standard industrial squirrel-cage induction motors and several examples of fractional horse-power motors for single-phase, three-phase and direct-current circuits. These motors have all been designed so that they are suitable for use with machine tools and are available in various types of mounting. A typical example of an industrial model is illustrated in Fig. 2, which shows a totally enclosed fan-cooled induction motor. The output of these motors ranges from 1 to 7½ h.p. and they are suitable for all situations where, owing to the presence of dust, dirt or damp, an ordinary ventilated machine is unsuitable. Two patterns were on view: one with standard foot mounting and the other with flanged-end shield mounting. In addition a 5 h.p. fan pole sectioned machine was on view. All these motors comply with the dimensions laid down in British Standard Specification No. 2083.

A COLLABORATION OF USERS

M.T.E. Control Gear, Limited, Leigh-on-Sea, Essex, were showing a new range of equipment, known as M.T.E. "Progress" control gear, which embodies three years development work and close collaboration with many classes of users so as to determine what is most needed to meet modern industrial requirements. The result has been the production of a series of relays and contactors which are simple to assemble and easy to maintain. They are also very compact in relation to their rating and performance so that space is saved, a feature which is particularly attractive when a combination of units is mounted on a multi-motor control panel or desk.

The new range consists of four main types: an eight-pole double-break relay, a miniature contactor and two heavy-duty contactors with current-carrying capacities of 30 amperes and 75 amperes respectively. The relay is capable of being built up into a minimum of 30 variations of contact assemblies, while the miniature contactor, which is of the same basic design, is intended for the control of fractional horse-power motors or light loads.

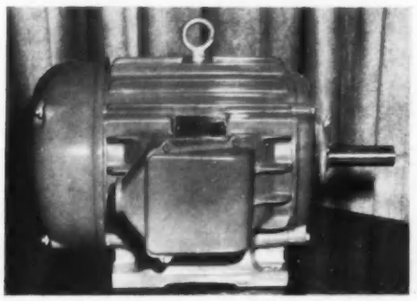

Fig. 2 Totally enclosed fan-cooled squirrel cage induction motor. (Crompton Parkinson Ltd.)

FRONT WIRING

The two heavy-duty contactors are both fitted with double break silver-tungsten contacts and can be supplied in pairs which are mechanically interlocked and are mounted on a common steel base for reversing duty and star-delta starting. An illustration of a 75 ampere contactor with the arc shield cover removed is illustrated in Fig. 3. Each individual contactor has three normally open main poles with two built-in auxiliaries. Four auxiliaries, either normally open or normally closed, can, however, be incorporated by fitting additional auxiliary attachments. Both electrical and mechanical interlocks are provided the latter being simple and positive and operating from the contact bridge. The contactors, on which there are two breaks per pole, have been specially designed for rapid operations.

One of the most important features of this equipment is the use of front wiring. This facilitates both installation and maintenance and makes it comparable with plug-in relays without sacrificing ruggedness and dependability.

The range is suitable for building into standard direct-on-line, star-delta and stator-rotor starters for use with alternating current motors with outputs up to 50 h.p. at 550 volts.

AUTOMATIC STARTER FOR SMALL MOTORS

A wide range of starting equipment was exhibited on the stand of Brookhirst Switchgear Limited, Chester. This included a new alternating-current automatic straight-on starter for the control of the smaller sizes of three-phase squirrel-

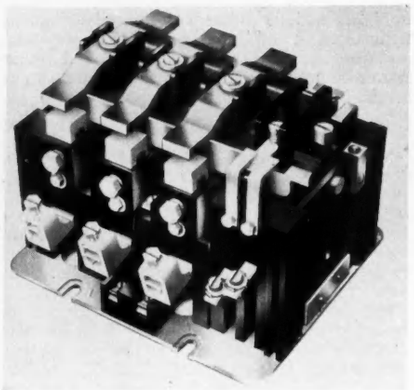

Fig. 3 75 ampere double-break contactor with arc shield cover removed. (M.T.E. Control Gear, Ltd.)

Fig. 4 Alternating-current automatic straight-on starter for smaller sizes of three-phase squirrel-cage motors. (Brookhirst Switchgear Ltd.)

cage motors which is known as Type SC-618 and is illustrated in Fig. 4.

The block-type contactor incorporated in this starter complies with British Standard specification 587/1940 for frequent duty (40 starts per hour). It also complies with British Standard specification 775/1956 since it has an enclosed standard rating of 22½ amperes and is suitable for Class II mechanised duty (40 operations per hour). This is equivalent to making and breaking category A4 for 7½ h.p. at 380 to 550 volts, or a maximum of 12½ amperes.

Three normally open main poles with one auxiliary are provided, but two more auxiliaries, which are normally open or normally closed can be added. The moving contacts are of the double-break quick-release type with sintered alloy or silver faces. A thermal relay, which protects the motor under overload or single phasing conditions, is directly connected to the contactor and after tripping can be reset either manually or automatically.

The starter is normally enclosed in a dust-protecting case of aluminium alloy which is arranged for wall mounting. Integral "start" and "stop" push buttons (with terminals for remote push buttons) are provided for control. The unit can be built into machine tools or mounted on a multi-motor control panel. A triple-pole load-isolating switch (in its own case), control-circuit fuses and an ammeter can also be provided.

A number of multi-motor surface mounting control panels for various machines also formed part of this firm's exhibit. These included one providing automatic star-delta starting for the main motor on a threading machine, as well as automatic straight-on starting for the hydraulic-pump and coolant-pump motors. The control panel for the motors on a fine boring machine was housed in an "accessible" type case with a deep removable front cover. It comprised equipment for automatic straight-on alternating-current starting and direct-current injection braking for the spindle motors, as well as straight-on alternating-current starting for the hydraulic-pump and coolant-pump motors.

Mention may also be made of a panel for a rigid hobber on which equipment for the straight-on starting of the cutter and hydraulic pump motors was mounted. Straight-on alternating-current starting and reversing of the rapid traverse motor was also provided, while the controls for three complete automatic operating cycles were mounted on the front of the case.

It is a little startling to have to record that nearly one hundred different items of control gear of interest were being exhibited on the stand of Igranic Electric Company, Limited, Bedford. These items, many of which embodied recent improvements in design, included limit switches, push buttons, controllers, change-over switches, speed responsive switches and alternating and direct-current starters. A range of alternating and direct-current solenoids were also shown in operation, as was the firm's Lo-Vo-Lite localised lighting equipment for machine tools.

It may also be mentioned that a full range of Igranic-Stromag clutches, which are being manufactured under licence from Maschinenfabrik Stromag and can find many applications on machine tools was also on view. These clutches are either of the dry-plate or lubricated-plate type and, being electromagnetic, can be remotely controlled from several points thus increasing their versatility of application. Further features are their short time response, high thermal capacity and low idling torque.

The time response is of interest to machine tool designers owing to its applicability to feed gears; while the compactness enables the transmission gearing to be constructed in much smaller compass. The high thermal capacity permits frequent operation and the acceleration of heavy masses and can therefore be advantageously employed on heavy machine tools. Since the magnetic lines of force do not pass through the discs the layout of these clutches can be adapted to a variety of mechanical applications.

Allen West and Company, Limited, Brighton, were exhibiting a full range of motor control gear including standard starters in projecting and flush mounting enclosures, special multi-motor assemblies and "purpose-designed" equipment.

Other features of the stand were full-scale part models of machines with specially designed control assemblies *in situ*. One such model was the main pillar of a Kendall and Gent plano-milling machine, while another was the bed stool of a John Lang lathe. In this machine the control gear is assembled on a double-sided panel, as shown in Fig. 5, which is arranged on a chassis framework, so that it can be withdrawn for adjustment and maintenance.

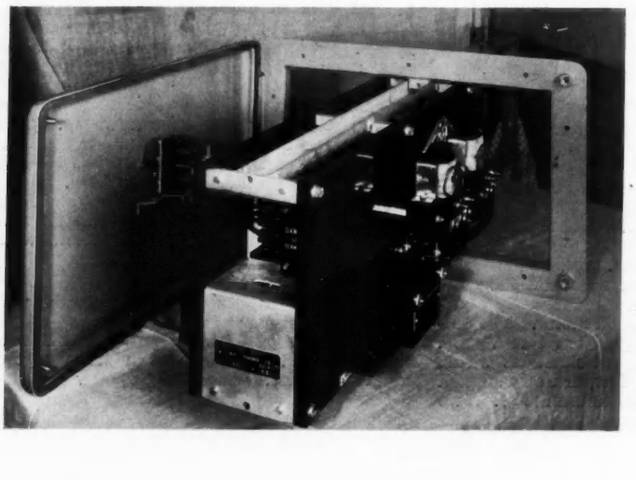

Fig. 5 Electrical lathe control gear which may be mounted on a chassis framework and so withdrawn for adjustment and maintenance. (Allen West and Co. Ltd.)

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METAL JOINING WITH "PLASTIC STEEL"

A new material, called Devcon—the Plastic Steel, is a combination of 80 per cent. of steel and 20 per cent. of a plastic product and was originally developed for making inexpensive tools, jigs, fixtures and moulds in the metal-working industry. Its use has now been extended to the building up of worn or broken parts, to the repair of leaks and to other applications.

The material is available in two forms, Devcon "A," a putty-like substance, which it is stated is as easy to handle as modelling clay, and Devcon "B," a viscous liquid which can be poured. Each form, which is packed in tins, is accompanied by a special hardening agent. This is added to the steel-plastic mixture and, after stirring, the mixture is ready for pressing or pouring into the desired shape. In the unmixed state the products will last indefinitely. When the mixture sets it is stated to become a permanently tough and rigid metallic piece.

The new material, it is claimed, possesses excellent resistance to many acids, alkalies and solvents, a high resistance to abrasion, a high compressive strength, 8 tons per sq. in., a tensile strength of 6·7 tons per sq. in., a high impact resistance and a low shrinkage during hardening (of approximately 0·0005 in.).

It will adhere to and bond steel, aluminium, bronze, brass and cast iron to themselves and also to porcelain and, in some cases, to carbide. It is pointed out that the material contains no inflammable solvents or substances which would evaporate or spoil.

The product has been developed by the Devcon Corporation, Danvers, Massachusetts, U.S.A., and is marketed in this country by E. P. Barrus (Concessionaires) Limited, 12-16 Brunel-road, Acton, London, W.3, who are the sole concessionaires.

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LUBRICATION ENGINEERS TO VISIT GERMAN STEELWORKS

Last October a party of steelworks lubrication engineers visited several German steelworks with the object of discussing common problems with their German counterparts, and seeing some of the latest developments in lubrication at German steelworks. The visit proved so successful that the suggestion has been made that it should be repeated this year.

It is therefore tentatively planned that the visit should take place in September for a period of three or four days and that half the members of the party should be steel or allied industry lubrication engineers and the other half be works engineers from the steel or similar industries. It is not intended to include persons employed by oil or other lubricant companies.

Interested persons should communicate with Mr. H. Peter Jost, who arranged the previous visit, at 5 Cranbourne-drive, Pinner, Middlesex.

ATOMIC REVIEW

Research and Developments

In the first part of this week's Atomic Review we continue our summary of the United Kingdom Atomic Energy Authority's second annual report, dealing with its comments on the problem of controlled thermonuclear reactions, fission reactor technology and the U.K. military programme. The second part, which also contains several items extracted from the report, is concerned generally with particle accelerators and concludes with a number of announcements.

Controlled Thermonuclear Reactions

Since 1948, the Atomic Energy Authority and its predecessors have supported a programme of research into the possibilities of obtaining economic power from controlled thermonuclear reactions. The occurrence of abundant fuel such as deuterium and other materials (see ENGINEERING, July 27, page 124) is a strong incentive to achieve this aim. The nuclear fuel must be brought to a temperature in the region of 100 million deg. C. to make a fusion reactor possible. Energy is given up by the hot gas in three ways: (*a*) by conduction to the surrounding medium, (*b*) by radiation (similar to that from the sun), and (*c*) by nuclear reactions. The energy released by nuclear reaction must be greater than (*a*) and (*b*) to make an efficient reactor. While it is possible to initiate a nuclear reaction at much lower temperatures, it is not yet certain that a pure fusion reactor can be built which yields more useful power than it consumes. Two main problems must be solved, namely—to bring a mixture of the light elements to the very high temperature mentioned above, and to maintain this temperature long enough for the energy released in nuclear fusion to be greater than that required to heat the fuel. Methods of heating the atoms of the reacting elements under conditions which provide good thermal insulation from the walls of the surrounding vessel, are being explored. The fuel would be a mixture of the two heavy isotopes of hydrogen, deuterium and tritium. Although tritium is not a naturally occurring element it could be made by the absorption in a lithium blanket of the neutrons from the deuterium-tritium reaction.

Many methods of heating a gas under conditions of good thermal insulation have been tested under laboratory conditions, and extremely high temperatures have been measured. The Authority's work is still in the laboratory stage, however, and many problems have to be solved before a practical fusion reactor will be possible. Universities and industry have helped the Authority on numerous aspects of this work. The assistance of specialists has been required in many branches of the natural sciences including those relating to ionised gases, hydro-magnetics, shockwaves and astrophysics.

Of related interest is recent news on thermonuclear fusion from America, where originally 35 companies were to be given access to classified information on the subject; however, it appears that this invitation has been withdrawn. Now, apparently, access to such data is only to be granted to certain very large concerns, who have insisted on being kept aware of fusion developments while they are investing large sums in fission. However, in its report to Congress for the first half of 1956, the United States Atomic Energy Commission, stated that during this period three major laboratories had moved forward in their controlled thermonuclear programmes. Emphasis was being laid in these studies on the use of deuterium, which, being abundantly present in sea water, would provide a source of energy virtually without limit.

Reactor Technology

With the advent of nuclear power stations and mobile reactors, attention is being focussed on the need to design shields of minimum cost and size. During the past year the properties of different kinds of concrete have been studied, and cost estimates have been made for various combinations of materials. Later the swimming pool reactor LIDO will assist in shielding research—an important consideration in the development of reactors for propulsion.

Liquids and gases to be used as reactor coolants have to be handled without contamination by lubricants or inward leakage from the surroundings. These surroundings may combine high temperature, corrosiveness and radioactivity. It has therefore been necessary to develop several unorthodox types of pump. Among these are the now familiar electromagnetic pumps. Pumps for gases have been developed using the gas itself as the bearing lubricant in bearings of the hydrodynamic type; such a pump, for example, is now being used to circulate carbon dioxide gas at fairly high temperature and pressure through BEPO in an experimental circuit. Gas bearings are also being employed in mechanical pumps for handling liquids which are not well suited to the electro-magnetic or submerged bearing types and which present special difficulties with respect to the use of shaft seals.

During the irradiation of fissile material considerable changes take place in its physical properties because of the formation of fission products within it. The economics of nuclear power depend on the frequency of fuel re-processing and thus on the "burn-up" or total energy which is released in the fuel. For the past year the irradiation work on fuels has centred on the problems of obtaining a burn-up of about 3,000 megawatt-days per ton of fuel (3,000 MWD/T). Even at 1,000 MWD/T, density measurement and microscopic examination show that, at high temperatures there is appreciable swelling of uranium metal due to the internal pressure of the gaseous fission products.

Work on liquid sodium and other metals has included a study of mass transfer of pipe materials from the hot sections of the circuit to the cooler parts, which, if unchecked, might lead to blockage of the pipes.

Materials Testing Reactor

The exploration of many of these fields entails the use of materials-testing reactors such as DIDO, which has recently been completed. The reactor comprises an aluminium tank in which canned fuel rods of enriched uranium are suspended. Heavy water is circulated through the tank, in such a way that a constant chosen level can be maintained, and serves as both moderator and coolant. The power of the reactor is controlled by flat strips of cadmium-plated steel which can be lowered like railway signals into the fuel element assembly. To reduce the escape of neutrons through the walls, a blanket of graphite (the reflector) is placed round the aluminium tank, and the whole is surrounded by a water-cooled thermal shield and a thick concrete biological shield. The complete assembly is installed in a gas-tight steel chamber. DIDO will produce a maximum heat output of about 10 MW, and will provide high and moderate intensity neutron fields both for the experimental testing of materials and for the production of radio-isotopes of high specific activity. It is expected to have the highest neutron flux of any reactor in Western Europe.

Calder Hall

Progress on the construction of the prototype nuclear power station at Calder Hall, a recent picture of which appears in Fig. 1, has continued throughout the period under review in accordance with the programme. The pressure vessel and the octagonal concrete shield of the first reactor were completed at the beginning of the year; the reactor could then be compared to a ship at the time of launching. Throughout the year the "fitting out" has proceeded, and at the end was so nearly complete that mechanical operating tests had started. Early this year therefore, progress had reached a stage when it was possible to decide that by October the station should be operating with sufficient reliability to supply electricity to the Central Electricity Authority's distribution system. This supply will be inaugurated by H.M. The Queen at a ceremony on October 17.

A difficult job during installation was building up from many thousands of carefully machined graphite bricks the elaborate moderator structure with its vertical channels in which the fuel elements and control rods are housed. Fig. 2 shows preparations being made to insert uranium fuel rods at the top of the first of the Calder Hall piles. Scrupulous attention to cleanliness was necessary both inside the reactor pressure vessel and also in installing the tubes in the heat exchangers, for any dirt deposited there might be carried by the cooling gas stream into the reactor. The banks of tubes, covered with millions of studs to improve the heat transfer, were shot-blasted on site to remove every trace of rust and then packed in boxes for transfer to the heat exchangers. To minimise the risk of water leaking into the coolant circuits the heat exchangers were designed so that all welds made on the tubes after erection were outside the vessel. The second reactor has progressed in line with the first but is programmed six months later. At the end of the period the graphite structure was complete, the four heat exchangers were in position, and the installation of the tubes in the exchangers was nearing completion. During the twelve months ending December, 1955, eight heat exchangers, weighing about 200 tons each, were successively lifted into position, by means of the same lifting tackle, moved between each lift. The generating equipment to be installed consists of four 23 MW turbo-alternator sets, two for each reactor. At the end of the period, the first of these was complete, while erection of the second was well

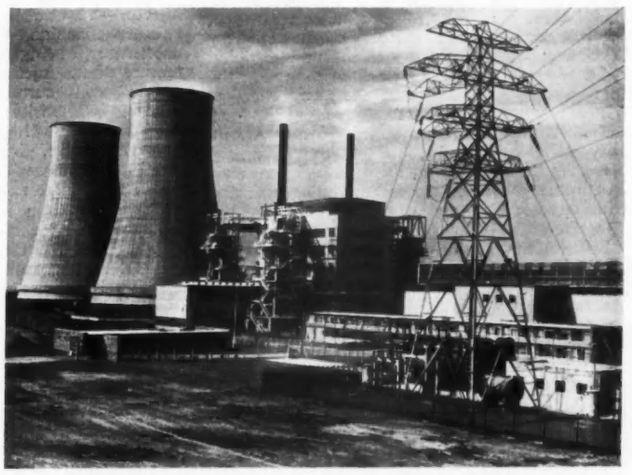

Fig. 1 Britain's first nuclear power station at Calder Hall will be opened on October 17 by H.M. The Queen. The reactor (centre) is one of two and is now undergoing tests after starting up last May. To the right is the turbine hall.

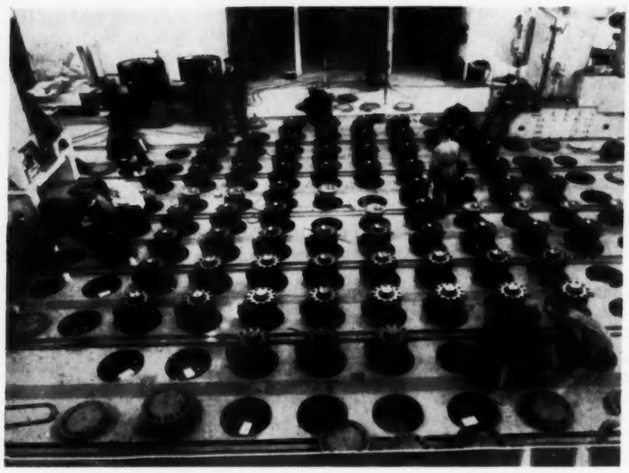

Fig. 2 [Preparations being made to insert uranium fuel rods at the top of the first pile at the Calder Hall nuclear power station.

advanced. One cooling tower, and the concrete structure of the second, had been completed; installation of the internal pack was going ahead. The associated mains and pump house were ready for service.

Military Programme

In June, 1955, it was decided to increase supplies of military plutonium but that this was to interfere as little as possible with the civil programme. To save time it was decided to build three new units of the Calder Hall type, each to consist of two reactors and the necessary ancillary equipment for generating electricity. One of these units is to be sited alongside the first Calder Hall unit and the two others at Chapel Cross, near Annan.

The United Kingdom Atomic Energy Authority have asked the A.E.I.-John Thompson Nuclear Energy Company, Limited, to start preliminary work on the design and construction of a research reactor at the Atomic Weapons Research Establishment. The reactor will use light (ordinary) water as moderator and coolant, and be designed to operate at power levels up to 5 MW. Discussions on design and layout, particularly concerning the experimental facilities to be provided, have been proceeding for the past six months. The reactor is fundamentally the same as that being built for the Associated Electrical Industries research laboratories at Aldermaston Court, but the experimental facilities have been altered to suit the special requirement of the Weapons Establishment. Cooling of this reactor will be by air blast coolers in the primary circuit. Certain constructional items associated with reactors, such as the biological shield and the reactor foundation, will be undertaken by the Ministry of Works for the U.K.A.E.A. The delivery of the equipment to the Authority's site is expected to be completed within twelve months. This reactor will be used to obtain fundamental data required in the fields of weapons development and reactors for military purposes.

Accelerators

The Authority has initiated design studies on machines to accelerate beams of protons to very high energies. Such machines are complicated and costly but are urgently needed to enable physicists of the Authority and the British universities to participate in research on the frontiers of nuclear physics. For the immediate future, attention is being concentrated on a new type of proton synchrotron accelerator giving an energy of 6 to 7 GeV. It is expected to produce about 100 times the intensity of present American and Soviet machines. The particles will be accelerated in the gap of a ring-shaped magnet of about 5,000 tons weight and about 120 ft. in diameter after receiving a preliminary acceleration to 5 or 10 million volts in a subsidiary machine. New methods of focusing the particles based on the "spiral ridge" principle are to be used in order to effect a saving in the total weight of steel and to enable the high intensity to be obtained. The advantage of this system may be gathered by comparing the weight of the magnet with that of the Soviet 10 GeV proton synchroton (ENGINEERING, vol. 181, page 542, 1956); in this case the magnet is said to weigh 35,000 tons. The design studies for the new British machine are expected to be complete by the end of this year.

Fig. 3 shows the high-intensity 500 keV injector—a Cockcroft-Walton generator—for another machine, a 50 MeV proton linear accelerator, being installed at Harwell. A feature of the injector is that it produces large pulsed beam currents, approaching 10 milliamperes in intensity; the beams of fast particles are thus more highly concentrated than is usually the case, giving more effective bombardment of the target. The machine will be used for fundamental research.

Reference to a further machine was made by Sir John Cockcroft during the recent conference on "The Physics of Nuclear Reactors" (ENGINEERING, July 6, page 29), where he described an electron linear accelerator now under construction at the Atomic Energy Research Establishment. It will have an electron beam current of one ampere in the pulse and an electron energy of 28 MeV with a pulse width of 1/5 microsecond and repetition frequency of 400 cycles per second. The neutron intensity from a heavy target will be about 100 times that available from the present 15 MeV linear accelerator at Harwell and will be 5×10^{16} neutrons per second in the pulse. In addition, a subcritical assembly of fissile material is to be used as a neutron booster to increase the intensity by a further factor of 10.

Other machines at Harwell are: a synchrocyclotron used primarily for accelerating protons and giving an energy of 175 MeV, an electron linear accelerator producing 15 MeV, a small Cockcroft-Walton generator for accelerating deuterons to an energy of 500 keV, a 5 MeV Van de Graaff machine mainly for protons and a similar 2 MeV machine for electrons. Previously there was also an electron synchrotron of about 30 MeV, but this was given to the Australian National University at Canberra. These are of course not the only accelerators in Britain; others are installed in universities, hospitals and other establishments. One reason for the increased interest in accelerators is probably the need to attract young physicists into the U.K.A.E.A., but there can be no doubt that fundamental research often leads to very practical results, and the importance of basic data on the atomic nucleus is underlined by recent interest in thermonuclear fusion.

What is understood to be a new kind of particle accelerator is to be installed at the Chalk River establishment of Atomic Energy of Canada, Limited, early in 1958. Known as the "Tandem Accelerator," this ten million volt machine will be developed and constructed by the High Voltage Engineering Corporation, of Cambridge, Massachusetts, and will permit the study in continuous detail of the energy level of heavy elements.

The new machine consists of two specially designed Van de Graaff generators placed end to end in a horizontal position, giving the accelerator an overall length of 34 ft. and a diameter of 8 ft. Weighing 35 tons it will be mounted on rails in an L-shaped building, 150 ft. long and 60 ft. wide. The building, now under construction at Chalk River, is located against a hillside so that the ground on one side will act as shielding against high-energy radiation; thick concrete walls will shield the other sides. A separate building will house controls and services. The beam of high-speed particles produced by the accelerator will be focused and deflected by a series of powerful electromagnets into an experimental area 25 ft. from the machine, which will be equipped with a unique switching magnet making it possible to shift the particle beam into any one of five directions. The accelerator will incorporate an unusual method of charge exchange whereby the electric charge of a nuclear particle is changed during acceleration to very high speed, permitting the same 5 million volt potential to impart the equivalent of a 10 million volt beam to the particle. Essential to the operation of the tandem-style Van de Graaff accelerator is a source of negatively charged ions. A source has been developed at the University of Wisconsin and with its aid positive hydrogen ions are made negative before being accelerated into the Van de Graaff machine. At the half-way point of acceleration, negative ions are stripped of their excess electrons so that they can accelerate "down hill" using the same voltage.

Another Van de Graaff accelerator has been

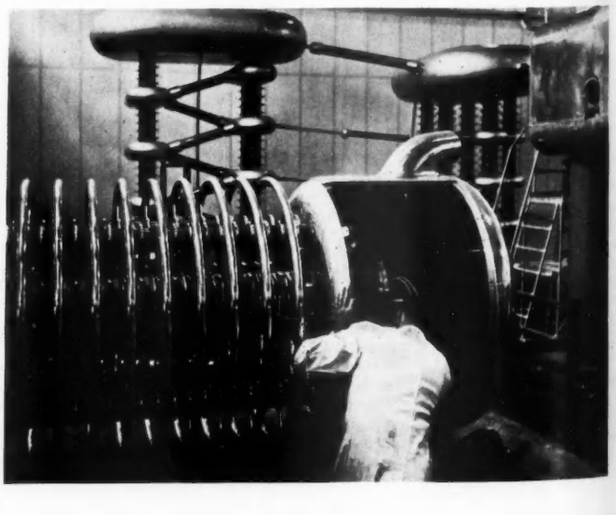

Fig. 3 High-intensity 500 keV injector for the 50 MeV proton linear accelerator now under construction at Harwell. The injector delivers pulsed beam currents approaching 10 milliamperes. Design studies are also in progress for a 6 to 7 GeV proton synchrotron.

made by the High Voltage Engineering Corporation for the Compagnie Française de Raffinage, who are concerned with petroleum refining and processing. This 2 million volt machine, which is to be installed in the firm's Paris laboratory, will be used for basic research studies relating to the effect of radiation on their petroleum products.

On June 22, we referred to the 25 GeV proton synchrotron being built at Meyrin in Switzerland by the European Organisation for Nuclear Research (CERN). Preliminary work has also been completed on a new synchro-cyclotron to develop proton energies of 600 MeV, details of which were given in another section of the straight and curved paths, appeared in ENGINEERING, vol. 180, pages 340, 374 and 530 (1955).

Announcements

Under an agreement between the United Kingdom and the Federal Republic of Germany signed at the end of last month, Germany may obtain, on terms to be agreed, research reactors and the necessary fuel elements, and unclassified information on topics to be agreed concerning the design, construction and operation of these reactors. The U.K. Atomic Energy Authority will, wherever possible, provide facilities for training, and the parties to the agreement will help each other to obtain the

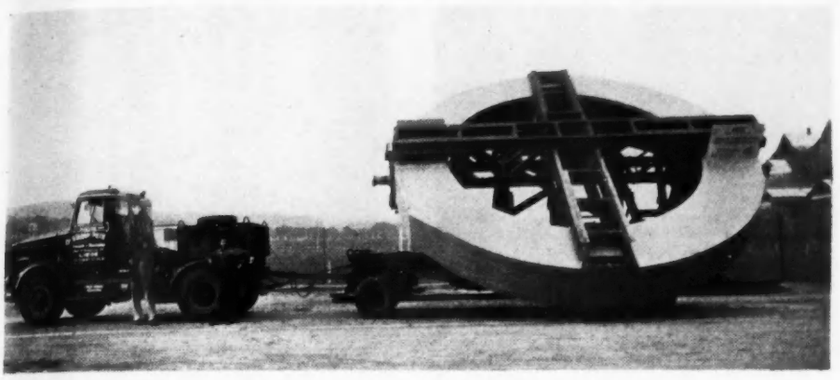

Fig. 4 First of two coils for the new CERN synchro-cyclotron, which is designed to accelerate protons to energies of 600 MeV. The coil is 7·2 metres in diameter and weighs 60 tons, and the trailer is built to tilt it hydraulically wherever the road requires it.

Organisation's first annual report. The magnet, which is due to be completed this month, will comprise 54 elements and weigh altogether 2,500 tons. One of two coils for the machine is shown in Fig. 4. Owing to their exceptional size and weight, a special trailer has been used for transporting them; it is provided with an hydraulic mechanism for tilting the coil whenever the width of road requires it. Each coil is, wound with 6,380 m. of aluminium conductor extruded in nine lengths, each of which forms a double pancake of 37 turns. The total number of turns per coil is 333, the diameter 7·2 m. and the weight 60 tons. The nominal current through the two coils connected in series will be 1,800 amperes and the total power normally dissipated with be 750 kW. The equipment will produce a high-frequency voltage in the region where protons are to be accelerated—this region being de-limited by the accelerating electrode, called the "Dee," and the copper lining of the magnet pole faces, called the Dee liner. The Dee will be connected to a variable condenser through a section of transmission line. The other side of the condenser will be grounded through a transmission-line stub. In this way the whole system will behave like a single transmission line, shorted at one end, open at the other, and with the variable condenser inserted at a point approximately one-third of the length from the shorted end. The resonance frequency will depend on the capacitance of the condenser. For large capacitances the behaviour of the system will approach that of a resonant quarter-wave line and operate at its minimum frequency. At the minimum capacitance the behaviour of the system will approach that of a resonant three-quarter wave line. The Dee will be located in the magnetic gap of the electromagnet and will be of a hollow light-alloy construction with copper lining, having a clearance radius of 2·4 m. and a clear internal height of 12 cm. The source of the protons to be accelerated in the machine will be of hot-cathode arc pattern.

Information concerning new accelerator installations has previously been given in ENGINEERING on June 1 (vol. 181, page 444) and June 22 (vol. 181, page 542). Articles explaining the general principles of accelerators, distinguishing between the various methods of accelerating particles in research quantities of materials needed for their atomic energy programmes. Under the agreement, the Germans will probably purchase from British industry a research reactor of the swimming pool type and a high-flux research reactor for testing materials similar to the PLUTO reactor under construction at Harwell. The agreement is for 10 years but may be renewed if both parties wish.

Steps have been taken in the interests of international trade and the interchange of scientific and technical information to speed the preparation of world standards in nuclear engineering (also in agricultural products). These moves follow from decisions reached at the annual meeting of the council of the International Organisation for Standardisation (ISO) held recently in Geneva. The council decided that its technical committees should, to begin with, consider the fields of (1) terminology, definitions and symbols; (2) safety standards for protection against hazards from nuclear radiation; and (3) standards for the safe and effective operation of reactors. In all this work there will be close co-operation with the International Electro-technical Commission (IEC), which has formulated its own plans in the electrical field.

A short course of 10 lectures entitled "Introductory Course in Nuclear Engineering," is to be held at the Wolverhampton and Staffordshire Technical College, Wulfruna-street, Wolverhampton, on Friday evenings, commencing next October 5. The course is intended primarily for engineers requiring a fundamental knowledge of nuclear energy as applied to power generation and will be followed by a more advanced course "Nuclear Engineering," commencing in January, 1957. The lecturers will all be specialists in the topics they discuss. Preliminary inquiries from interested firms and individuals are invited and should be addressed to the Head of the Department of Mechanical Engineering at the College.

Unfortunately there was a misprint in each of the Atomic Reviews in the issues of July 27 and August 3. The former included a diagram (page 125) representing the so-called carbon cycle in which an arrow (on the right of the stage marked by an asterisk) was printed the wrong way round. In the caption to Fig. 2 in the issue of August 3 (page 158) reference should have been made to the uranium 233-thorium cycle and not as printed.

The automatic pilot's life-jacket inflator is seen here attached to a CO_2 life-jacket cylinder. It will automatically inflate a life-jacket 15 seconds after contact with water.

AUTOMATIC "MAE WEST" INFLATOR

A new automatic life-jacket inflator that inflates a pilot's "Mae West" life-jacket upon contact with water has been developed by North American Aviation, Incorporated, Los Angeles, California.

The search for an automatic inflator was initiated last year when North America's test pilot, Mr. George F. Smith, became the first man to survive after baling out of a plane at supersonic speed at low altitude. Mr. Smith, who landed unconscious in the Pacific Ocean off Laguna Beach, California, would have drowned if men in a nearby boat had not pulled him from the water 50 seconds afterwards. His life-jacket, which had to be manually operated, was not inflated.

The entire automatic inflator assembly weighs 5 oz., and will inflate a life-jacket within 15 seconds after immersion in water. It consists of a cap, a piston, a spring-loaded plunger, a soft rubber flutter valve and an effervescent pill (60 per cent. tartaric acid and 40 per cent. sodium bicarbonate). The automatic inflator does not interfere with the manual operation.

As the pilot drops into the ocean, water rushes through an opening in one end of the metal cap, forcing open the rubber flutter valve. The water passes through the valve and strikes the surface of the tablet causing it to dissolve and produce a cloud of gas. The gas pushes the flutter valve back into place at one end of the small chamber and forces down the piston at the other end. This in turn releases the spring-loaded plunger, which strikes the manual operating lever with the force of a hard pull by a man, fires the carbon-dioxide cartridge and thus inflates the jacket.

The device cannot be set off accidentally by rainfall, heavy dew or accumulated moisture, such as might be encountered by service pilots under field conditions, because the flutter valve holds the opening closed until it is forced open by the pressure of a body of water on the outside.

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COMPOSITE DRAWING BOARD

A new type of composite drawing board has been developed by Angula Engineering Company, Glaskin-mews, Pembury-road, Clapton, London, E.5. It comprises a laminated wood base board to which is bonded a resilient composite surface which in addition to eliminating "ghosting," provides a restful light-green surface which is washable and encourages the use of adhesive tapes—thus prolonging its useful life. Normally the detail paper is placed immediately upon the composition surface. However, where tracing is undertaken, a single sheet of a lightweight white paper may be used as a backing.

COMPRESSED AIR RESERVOIR FOR HIGH SPEED WIND TUNNEL

40 ft. Diameter Welded Sphere

Under construction at the Woodford, Cheshire, factory of A. V. Roe and Company, Limited, is a supersonic wind tunnel with a flexible nozzle section, designed to operate over a speed range of Mach 1·5 to Mach 3·5. The tunnel, which will have a working section 27 in. by 30 in. to accommodate high-tensile steel models 18 in. long, is of the "blow-down" type, requiring only 500 h.p. to provide the wind.

The tunnel is connected to a 40 ft. diameter sphere, shown in course of erection in the accompanying illustration, containing compressed air at a pressure of 115 lb. per sq. in. absolute. The air is released to the working section of the tunnel through a quick-operating valve, and the supply is sufficient for "runs" of about 1 minute.

The storage sphere was designed and constructed by Whessoe Limited, Darlington. The steel shell, 1¼ in. thick, is of N.D.1 boiler quality having a minimum ultimate tensile strength of 26 tons per sq. in. This quality of steel, which has enhanced ductility at low temperatures, was chosen to guard against brittle fracture.

Particular attention was paid to the design of openings in the shell. The type of reinforcement used in the large connections for manholes and air outlet was designed to minimise stress concentrations, an important consideration because of the frequency and rapidity with which the sphere pressure will be changed.

The shell is completely butt-welded, and to prove the soundness of the welding all seams are subjected to 100 per cent. radiography after dressing and grinding smooth. In addition all welders were fully tested before employment on the job and test pieces of their work were taken periodically for mechanical testing. The welds of small connections into the shell which are not accessible for radiography are examined by magnetic crack detection equipment using a fluorescent magnetic ink. All plates containing openings were stress-relieved individually after welding-in the reinforcement ring or branch. Upon completion, the sphere will be hydraulically tested to twice the design pressure.

The sphere is supported on eight columns which join the shell in the region of the equator. They are designed to carry the weight of the shell and its water content of 950 tons and are based on reinforced concrete piles.

This storage sphere is to hold air at 115 lb. per sq. in. absolute for operating Avro's new supersonic "blow-down" wind tunnel. It will, therefore, be subjected to repeated pressure loadings, and particular care has been taken to minimise stress concentrations at the various shell openings. Towards the end of August the sphere will undergo a hydraulic test to twice the design pressure.

WELDING RESEARCH

Brittle Fracture, Fatigue and Corrosion, Structures and Processes

Important discoveries on the mechanism of brittle fracture in welded steel plates are reported in the Eleventh Annual Report, 1955-1956, of the British Welding Research Association. Tests on 36 in. square plates 1 in. thick with central longitudinal butt welds, carried out in a 600 ton test rig at low temperatures have shown that the residual stress due to welding plays a considerable part in the spread of cracks from fine sawcuts simulating weld defects, and that a complete fracture can occur without impact under loads well below the design load. In specimens where the residual stress had been relieved, the crack propagated across the plate specimen only when the yield point of the material had been reached.

Fatigue investigations carried out by the Association include work on pressure pipelines with welded butt joints, from which it has been shown that the only welding defect that significantly affects the alternating-bend fatigue strength is lack of penetration. Alternating torsion tests on welded thin-gauge structures as used in automobile chassis members have shown that completely closed sections with continuous welds are stronger than sections built up by intermittent welding.

Stress-corrosion cracking in welded gas mains has been found in all but the more recently-erected British gas plants, but an external survey has confirmed that where stress-relieving has been carried out prior to erection, no cracking occurs. Increasing interest in the possibilities of using low-alloy steels for rail and road bridges and other structures will focus attention on the Association's current investigations on heat-affected-zone cracking in a wide range of materials and conditions, which aim at establishing a general theory; so far, there are indications that heat-affected-zone cracking during cooling can take place at temperatures within the range 160 to 100 deg. C.—lower than the critical temperature of 300 deg. C. that had previously been suggested.

Other items on the "weldibility" research programme include the welding, both by electronic and by resistance methods, of zirconium and titanium alloys. For arc-welding titanium a chamber has been constructed which can be charged with argon, and special torch nozzles have been made for welding in conditions under which the titanium parts cannot be completely enclosed.

On frame structures, full-scale tests at the Association's laboratories at Abingdon have shown that pile foundations only a few feet long allow complete advantage to be taken of foundation rigidity for rigid-joint structures.

The Association's work on nozzles in pressure vessels has shown that nozzles protruding on the inside provide an important reinforcing effect; and under pulsating pressures, fillet-welded nozzles behave as satisfactorily as nozzles attached by full penetration welds. The recommendations arising from this work, still continuing, will eventually result in substantial savings for industry.

Welding processes investigated during the year include the gas-shielded metal-arc welding of ferrous metals. When welding mild steel, both the quality and the mechanical properties of the weld are improved by carbon dioxide shielding, and good results on a 3½ per cent. nickel-chromium-molybdenum steel 2 in. thick suggest that the process will be satisfactory for welding alloy steels. Trial welds on 18/8 stainless steel have also shown promising results.

The new metallurgical laboratory at Abingdon, with a floor area of 16,000 sq. ft., is now nearly complete, and the Association's staff are due to move in there during September.

Brittle fracture tests on 36 in. square plate specimens 1 in. thick have shown that, due to residual stress, complete fractures can spread across the plate from weld defects under steady loads well below the design loads.

In Parliament

USE OF SOLAR POWER

Anxiety to improve Britain's available sources of energy was noticeable in a number of questions asked in the House of Commons last week. Mr. Ellis Smith (Labour) wanted to know what Government-sponsored experiments were taking place regarding the problem of obtaining power from the sun, whether conducted by the Ministry of Fuel and Power, or by private concerns working in conjunction with that Ministry, or by the nationalised industries. He also asked what preparations were being made for the manufacture of solar batteries and the utilisation of chemical energy through the injection of hydrogen gas.

Mr. David Renton, the Parliamentary Secretary to the Ministry of Fuel and Power, replied that there was but little prospect of obtaining power from the sun on a useful scale in this country, because there was not enough sunshine and Britain was far from the tropics. No Government-sponsored experiments were now taking place, although Government scientists were keeping in touch with the work being done in other countries. American scientists had recently found a means of using sunlight to convert water into hydrogen and oxygen gases, but the process was still in its infancy, and its development on a larger scale presented many difficult problems.

Referring to the main issue, Mr. Ellis Smith said that, while the politicians were laughing, scientists were getting on with their experiments, but the Minister pointed out that, in this country, even the scientists were handicapped by the fact that the sun's heat and light were not very intense and their staying power not very great.

SILT HOLDS UP SEVERN BARRAGE

Another problem raised by Mr. Ellis Smith was the question of harnessing the Severn river and estuary, in order to obtain hydro-electric power. He considered the inactivity of the past in this regard to be a " terrible indictment " of former Governments. He said that his interest in the matter had been stimulated by a very fine pre-war experience, when he had spent a day poring over drawings, in company with Mr. A. Stubbs, who was a director of Fodens Limited, an adviser to the Metropolitan-Vickers Electrical Company, Limited, and an authority on hydro-electrification. France was about to take action to make use of the tides for hydro-electric purposes.

Mr. Renton said that the results of recent research into the Severn Barrage project had been discouraging and that, so far as was known, no other tidal inlet in this country offered any better prospects. He appreciated what had been said, but it had to be borne in mind that the physical difficulties of the Severn Barrage project were immense, owing to the tremendous amount of silting which took place with each incoming tide. So far as the situation in France was concerned, the authorities there had managed to find two suitable sites, where silting did not present the same problem.

NUCLEAR POWER PROGRAMME

Subsequently, Mr. James Callaghan (Labour) expressed the hope that Mr. Aubrey Jones, the Minister of Fuel and Power, would review the programme of the United Kingdom Atomic Energy Authority, in order that the contribution which nuclear power could make to Britain's fuel requirements should be accelerated. Mr. Callaghan considered that the programme was moving along too slowly and that, even on the basis of present knowledge and of the present operations at Calder Hall, there was already a case for substantially speeding up what the Government proposed to undertake. Another Labour member, Mr. William Warbey, referred to the publication of the Authority's second report, and asked the Minister to state what revisions had been made in the plan for nuclear power developments, which had been announced in February, 1955.

In reply, Mr. Jones said that, as he had indicated in the debate on the Coal Industry Bill, the programme set out in the White Paper of February, 1955, was the minimum which was expected, and that he attached the highest importance to expanding and accelerating that programme as much as was practicable. He had no doubt that the Government would be able to achieve more than was first thought possible, but exactly how much more could not be determined until the plans for the first stations, which were due to be submitted in the coming autumn, had been examined and the appropriate conclusions drawn. He fully accepted the view that there was a case for speeding up the nuclear power programme and it was not true that it was being in any way delayed. Clearly, it would be premature to do anything until the plans of the first stations had been received and the costs and designs fully examined.

COAL PRODUCTION PROBLEMS

Answering questions by Mr. Ronald Bell (Conservative), who had spoken in favour of the speedy abolition of coal rationing, Mr. Jones said that the current cost of rationing worked out at about £1 million per annum. Although any estimate must be extremely speculative, he considered that it would not be safe to take a lower figure than two million tons as being the amount of additional coal that would be required to abolish domestic fuel rationing. It was the aim of the Government to end coal rationing as soon as they could, but, to do so at this juncture, would entail the risk of heavy imports, the cost of which would be far greater than the cost of rationing.

As to concessionary coal, Mr. Jones said that about five million tons were being issued to some 630,000 employees of the National Coal Board, as well as to certain pensioners, miners' widows and other persons, each year. If these people were ordinary members of the community, their total permitted quantity of house coal and boiler fuel would amount to nearly three million tons.

Mr. Albert Roberts (Labour) pressed the Minister to promote the increased consumption of oil by industry, in view of the expenditure falling upon the N.C.B. in consequence of the high cost of importing coal. On this matter, Mr. Jones said that the cost of supplying imported coal had been reflected in coal prices and this, in association with other factors, had already resulted in a considerable expansion of oil consumption.

JAVELIN AIRCRAFT CRASH

An officer, representing the Chief Inspector of Accidents, fully investigated the accident to the Javelin fighter aircraft, in which a test pilot of the Gloster Aircraft Company Limited, was killed, according to a statement by Mr. Reginald Maudling, the Minister of Supply. He informed Mr. Frank Beswick (Labour) that the crash was attributed to the aircraft encountering a condition known as the stabilised superstall. That condition had not previously been experienced. In the earliest test reports some criticisms of the controls had been made and improvements were devised, but the reports did not suggest the possible occurrence of a superstalled condition and were not such as to indicate that the aircraft would be dangerous in the hands of an experienced test pilot.

TESTS OF PROTOTYPE AIRCRAFT

In another statement, Mr. Maudling said that, in Government contracts for prototype aircraft, the manufacturing companies had an obligation to provide the Ministry of Supply with copies of every test report, together with copies of any records obtained from recording instruments and reports of any preliminary tests. These documents were carefully scrutinised, both at headquarters and at the experimental establishments. In view of these facts, he saw no justification, he told Mr. Beswick, for holding a special inquiry into the question of his Ministry receiving all relevant reports on prototype aircraft from the test pilots of the aircraft companies, as Mr. Beswick had proposed. Another suggestion by Mr. Beswick was that, in the case of the Javelin and Hunter aircraft, machines were put into production when faults were still present in their designs, an example of which was that dive brakes had had to be inserted in Hunter aircraft after a number of these machines had actually been built. On this point, Mr. Maudling said that he had looked into this matter very carefully and he was satisfied that full reports were submitted by the aircraft companies at all times. The Gloster Company especially had always made it a practice to send the Ministry full reports of what its test pilots had to say.

Cut-Outs on Railway Third-Rail System

In reply to Mr. Gresham Cooke (Conservative), who raised the matter, Mr. Watkinson declined to give a general direction to the British Transport Commission to consider the possibility of installing machinery for the automatic cutting-off of electric current on the railway third-rail systems, when accidents occurred. He said that the complete modernisation of the power-supply arrangements in the London area of the Southern Region's third-rail electric system was actively in hand, and should be completed by the end of next year. This new equipment included automatic cut-out devices of the most modern types. He was satisfied that all practical steps were being taken to meet the conditions Mr. Cooke had in mind.

Hydro-Electric Power Developments

Mr. Ellis Smith also asked what proposals the Minister of Fuel and Power had in mind for the development of hydro-electric power in Britain. Mr. Renton said that the principal scope of British hydro-electric schemes was in Scotland, and that these were the responsibility of the Secretary of State for Scotland. So far as England and Wales were concerned, his own Department had no proposals other than those contained in the North Wales Hydro-Electric Power Act, 1955. Hydro-electric power was at present supplying energy equivalent to a little over one million tons of coal per annum and, on the basis of existing plans, this amount would increase to close upon the equivalent of two million tons per annum by the early 1960's.

Europe's Need of Energy

All member countries of the Organisation for European Economic Co-operation have been invited to be represented on the working party set up by the Organisation in mid-July to examine the problem of future supplies of energy in Europe. According to a reply by Mr. Harold Macmillan, the Chancellor of the Exchequer, to Sir James Hutchison, Bt. (Conservative), the Government is in agreement with the formation of this working party and will be represented upon it.

Attracting Technology Students

Mr. Austen Albu (Labour) wanted the Chancellor of the Exchequer to take further steps to accelerate the increase in the numbers of university students reading science and technology. In reply, Mr. Macmillan referred to the statement of the Lord Privy Seal on June 21, in which he said that the country could look forward to an increase of the order of 60 per cent. in the number of students of science and technology, during the next five years. That increase, Mr. Macmillan emphasised, would be assisted by the provision of new and enlarged laboratories, and other buildings. The Government's special programme in this field, under which about £1 million worth of new building has been started annually since 1954, would receive a great impetus in 1957, when new construction amounting to £4,300,000 would be put in hand. All this building work was in addition to the Imperial College scheme, with its target of 3,000 students within the next seven years.

THE HUMAN ELEMENT

Branches' criticisms of the T.U.C.—Professional trade union leaders—Steel strikes in the U.S. and the U.K.—The B.S.A. affair—Armistice in the motor dispute—Ministry of Labour discussion group on the position of foremen.

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The Brighton Fog

According to a resolution of the public service employees, T.U.C. leaders should "exercise more effective leadership in our industrial life" and the General Council should take "a more active and positive role in our industrial affairs." The implied censure fits the situation well enough: rarely has top union leadership appeared more befogged by the burning issues of the day, or appeared more out of touch with reality. The agenda for the annual Trades Union Congress at Brighton (September 3 to 7) promise some fierce debates. As in the case of the Confederation of Shipbuilding and Engineering Union's agenda (see "Higher and Shorter") the majority of resolutions are concerned with economic policy and wages. The belligerent tone of most of them does not suggest very ready co-operation with the Government on price restraint.

There is emerging from resolutions, in the T.U.C. agenda as well as in agendas for other conferences to be held within the next few weeks, a deep anxiety about economic affairs. Industrial production is not rising as expected. According to some industrialists it is due to a fall in the demand for most goods, particularly overseas. It is difficult to see what the unions can do about this; so far the emphasis has been on national control and industry-wide planning. Suggestions will be made at Brighton for a National Planning Board for Automation under Ministerial control, and for a permanent commission to be drawn from Parliament and from scientists, unions and employers which would be concerned with technological change and its impact on industry and society. Everywhere there is a feeling that something needs to be done about many things, but so far little that is concrete has emerged.

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Higher and Shorter

Already it is clear that engineering unions are to press for higher wages and for shorter working hours at the annual conference of the Confederation of Shipbuilding and Engineering Unions in September. Eleven resolutions call for wage increases or express opposition to any form of wage restraint. The 40-hour week—recently rejected by the employers—will be discussed and is likely to be put forward again backed by a unanimous vote. There are other resolutions on working hours, one from the constructional engineers (who want a 15 per cent. rise) advocating "some system for controlling overtime." There are calls for pension schemes, but none for the allocation of shares to employees or for profit-sharing schemes. These unions, including the A.E.U. and the Foundry Workers, want more nationalisation in the industry. The call for "a common policy on automation" shows the same kind of hankering for national regulation of everything as employers are showing in the case of redundancy. On that subject there is no resolution so far, but it will in all probability form one of the main topics of discussion.

The Confederation's meeting is likely to prove quite different from any held since the war. For the first time union leadership has been found wanting on a strike issue. Equally new is the problem of redundancy, whether through lack of orders or through the introduction of automatic processes. A rude awakening awaits the leaders, and changes are likely. Wiser, more active and more far-sighted leadership is an urgent need of the engineering trade union movement. In this respect higher salaries may prove an essential prerequisite. The era of the "professional"—as opposed to the "political"—trade union leader, with large technically trained staffs, may not be very far around the corner.

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A Tale of Two Strikes

The United States came late into an era of enlightened industrial relations policy, but once there it has travelled fast. This has been apparent for some time, for example, in the way in which wage agreements in the automobile industry have led the way in long-term contracts. A somewhat similar example is now forthcoming in the settlement of the steel strike where in exchange for a three-years no-strike contract, the steel workers have secured substantial benefits in the way of pay increases and social benefits. This strike was robust, though not violent while it lasted, but there has been evidence of constructive fresh thinking in the terms of its solution.

It remains to be seen if anything as really positive comes out of the strike of steel maintenance workers in this country. The British steel industry has had until now a unique record in its industrial relations for harmony between management and labour. No other industry, to judge from its stable history in these matters, has been better placed to do some constructive, bold thinking about wage differentials for skilled men. It is high time too, that wage negotiations with the employers in this country went further than thinking of two silly figures and compromising on the mean. No country has played a larger part in the last 100 years to build up a code of good industrial relations than this country. To-day it is being left behind by newcomers in the field. The industrial system that produced Robert Owen and the Tolpuddle Martyrs owes them both some new ideas on wage negotiations and earnings formulae in the Twentieth Century.

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Publicity and Respectability

One of Shaw's characters, speaking of the peculiarities of his fellow Englishmen, says in one of his plays ". . . though our enemies may rob us of our clothes, they will never rob us of our respectability." Something of this attitude was present at Grosvenor House, London, last week when the last bitter hours of the B.S.A. affair drew to a close. When all the publicity-hunting and amused cynicism has passed there remains in this much over-publicised affair an important lesson for those who run British industry. It is this. He who offends against the not particularly lovely English worship of respectability, offends indeed.

There were plenty of people who turned up at the B.S.A. extraordinary meeting prepared (inspired or otherwise) to speak up for the banished chairman—and most who spoke were of his persuasion. There were plenty more who were prepared to snigger at the lapses into bad taste and bathos. Not a few on both sides of the argument viewed with distaste the written statement read by a representative of the Prudential Assurance Company. But these few who strutted and fretted their hour upon the stage had little influence either way. The shareholders of the company were asked to vote on an issue of personal conduct—and there is nothing more English than an Englishman when he gets a voting paper in his hand. On such occasions he is moved by instinct and on this one he thought by a substantial majority that the whole thing wasn't really very nice. Basically it was as vague and intellectually unresolved as that.

Vague though it may be, the sanction is there and real enough for any other industrial leader to invoke against himself if he should be so minded. He has been duly warned that the spirit that broods over the Royal Enclosure at Ascot has other powerful manifestations.

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Hopes Rise at B.M.C.

An atmosphere of compromise was beginning to prevail at last week's meetings between representatives of the management of the British Motor Corporation and of the 15 unions concerned in the dispute. Union leaders were optimistic on the likelihood of a settlement before the end of the Corporation's annual holidays on August 13. A large measure of agreement was reported on the matter of consultations before workers are declared redundant, and the question of compensation payments was discussed in general terms. It would seem that a solution might be found on the lines of a "national agreement on compensation payments for redundancy." The representatives of the company's management held out firmly against the negotiation of a separate agreement between B.M.C.'s management and employees. The discussions were therefore adjourned for a week to give both sides an opportunity to consult their organisations. The management will now consult with member firms of the Engineering Employers' Federation to evolve "a firm offer on compensation on a national scale." This follows well the beaten tracks of employer-employee relationships. Yet there is much to be said against any national agreements of this kind. Conditions differ too widely between industries, and between companies within each industry. The general effect tends to be restrictive and unnecessarily inflexible.

Emerging from it all is the ineffectiveness of union leadership after a very long period of prosperity. Nothing was prepared to enable a constructive approach to the problem of redundancy to be made. No provision has yet been made to deal with such an emergency. In all probability union leaders are still reading books on the subject: they have much ground to make up.

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Training for Supervisors

The importance of training the supervisor or foreman is the theme of a booklet put out by the Ministry of Labour as the fourth in the "True Story" series. The booklet takes the form of a discussion among five types of industrial worker from a company director to a shop foreman on the conclusions of the 1954 Report of the Committee of Inquiry on the training of supervisors.

The discussion started where the report left off—that is, with its conclusions. These were that the responsibility for training supervisors is with senior management, that training of a purely academic nature is useless and that no training is worth while if the foreman's position as a member of the management team is not secure. The report's conclusions are impeccable. The interesting thing about a discussion on them is how they are interpreted by individuals in industry against their own background. It is of interest in this case, for example, that the foreman felt some misgivings about the usurpation of his position by technical people, and that he was backed up in this opinion by the training officer present. All laid stress on the importance of consultation, bringing in the foreman and supervisor at an early stage.

Publications of this kind, and this one is no exception to it, would benefit from a slightly lighter touch. The discussion is informed and reasonable. Those taking part say all the right things which enlightened people in industry in their positions should say. But they are not "people" and the pamphlet does not give out the atmosphere of industry. A few flippant remarks, an occasional brush of heightened feeling in the dialogue and a few resounding prejudices would add realism and make such efforts easier to read and better remembered.

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